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An evolutionary analysis of the relationship between ownership institutions and energy transitions

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Abstract

Previous grand energy transitions have been accompanied by changes in the ownership institutions governing a society's main energy resource: hunter-gatherers generally follow 'communal' ownership systems that distribute resources fairly equally; agriculturalists typically live under hierarchical 'command' ownership institutions; and contractually defined 'titled property' has become widespread in societies that run on fossil fuels. In this thesis, I ask why these different ownership institutions have evolved to govern these different kinds of energy resource. I begin by arguing for a taxonomy of ownership, drawn from debates across the humanities and social sciences, that distinguishes between the ownership of resource stocks such as farmland, of resource flows such as crops, and of fund-service resources such as tools. Using this taxonomy, I construct an evolutionary game theory model of the evolution of ownership. Existing models explain only the evolution of hypothesised possessive instincts, so I extend this approach to model a mechanism by which the communal, command, and titled property ownership institutions typical of human societies may have evolved. One particularly significant outcome of the model is that it suggests titled property institutions are likely to survive when governing energy resources that are expanding. I present a long historical outline of the evolution of titled property from its ancient origins to the modern period, which does indeed suggest that titled property institutions have historically survived only where they govern expanding energy resources. The thesis thus contributes a nuanced taxonomy of ownership institutions governing different resource types, an evolutionary model of human ownership institutions, and an analytical narrative of the evolution of titled property. It also suggests that titled property institutions in their current form may be unlikely to survive should energy resources become significantly constrained in the future.

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I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

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Chapter 1

Introduction: energy and ownership

Previous grand energy transitions – to hunting large animals, to domesticates, and to fossil fuels – have brought civilisational transformations in economic and political structures. A question of particular interest to political economists is why these transitions have been accompanied by changes in the ownership institutions governing resources, a question central to the study of political economy since the early beginnings of the discipline (for example A. Smith 1763 i.27, Marx 1867: 831, 1894: 357-358). In this thesis, I examine this question, making use of new evolutionary modelling techniques and

using evidence that has only more recently become available.

Evolutionary modelling is a particularly appropriate method for approaching this question, as the development of such techniques begins with simple models of the evolution of the hypothesised possessive instincts of animals (J. M. Smith 1979, 1982). Since then, a growing body of evolutionary game theoretic techniques has been used to model the ways in which cultural and physical traits in a population evolve in response to changes in the environment and interactions with others in that population (Nowak 2006). Until now, though these techniques have been used to model the evolution of ownership, they have stopped at the evolution of hypothesised possessive behaviours in nonhuman animals and have not yet been used to model the more complex ownership behaviours among humans. This is, in part, due to the fact that these evolutionary models have for the most part been developed by researchers studying nonhumans, but it is also partly due to the dominance of what might be called the 'standard story' of the evolution of ownership (Pagano 2016), in which this evolutionary process is characterised as the establishment of possession over an ever greater number of things (see for example Demsetz 1967, North and Thomas 1977, Krier 2009, and Fukuyama 1992, 2011). Now, however, the important differences between different forms of ownership have begun to be brought to the fore (van Griethuysen 2012, Heinsohn and Steiger 2013, Hoffmann 2013, Hodgson 2015, Cole 2015, J.-D. Gerber and J.-F. Gerber 2017) and this has made possible

a more conceptually nuanced narrative of the evolution of ownership.

This thesis, then, draws together these literatures on energy and on ownership to develop a more complete narrative of the evolution of ownership. I begin this chapter by setting out in more detail the aims of this project and the steps I have taken to achieve those aims. In the second section, I set out the research question, and in the third section give an overview of the thesis as a whole to indicate how I go about answering that question.

1.1 Purpose of the project

An underlying motivation for this project is to better understand the relationship between energy transitions and ownership institutions, so that this might provide a framework for analysing the changes that might accompany a future energy transition, away from fossil fuels. It has often been argued that a promising approach to better understanding future energy transitions is to examine the changes that have accompanied previous energy transitions (Passet 1979, Sieferle 1982, Debeir et al. 1991, Krausmann et al. 2008, R. C. Allen 2012, Grubler 2012, Pearson and Foxon 2012, Smil 2016). This literature on historical energy transitions suggests categorising societies based upon the resources from which they gain the majority of their energy. Broadly, these are foraged resources, hunted and gathered resources, domesticates, and fossil fuels. Foragers use only their bodies to obtain energy from the resources

they gather, whilst hunter-gatherers use exosomatic tools and, particularly, fire to capture and process wild foods; agriculturalists and pastoralists obtain their energy from domesticated varieties of plants and animals, whilst in fossil fuelled systems energy is used by burning mineral resources to drive machines (see Section 1.2 below).

An alternative, complementary, way of categorising societies is in terms of their political and economic structures (Polanyi 1944, Polanyi 1971, Pryor 2005, Heinsohn and Steiger 2013). One key feature of societies is the rules that govern the way that resources are transferred from one individual to another, that is, their ownership institutions. Broadly, there are four different kinds of ownership institution: possession, communal ownership, command ownership, and titled property (see Chapter 3 of this thesis). Though these represent ideal types, and are not to be taken to fully encapsulate all of the resource transfers that actually occur in any given society, in the simplest terms possession is, in theory, where the first possessor of a resource retains possession of it, whilst under communal ownership the first possessor shares what they obtain with other members of the group; and in societies following command ownership institutions resources are transferred to individuals of higher social status, whereas under titled property institutions resources are transferred according to contract (Krier and Serkin 2015, Boehm 1999, 2004, Heinsohn and Steiger 2013, Lau and Smithin 2002, Strunz et al. 2015).

1.2 Defining energy systems as the empirical object

Natural systems were long described in terms of energy flows, an analysis more recently extended in various ways to include human social systems (see Lonergan 1988: 133, also Chapter 2 of this thesis). For the purposes of this thesis, I here follow energy analyst Vaclav Smil in defining energy systems as biophysical systems consisting of natural energy sources, their conversions, and their specific uses (Smil 2010: 1). This analytical division between, in the words of Debeir et al. (Debeir et al. 1991: xv), "the social, technical, political, mental and other dimensions" that societies use to organise the "mobilisation of energies" and the biophysical system itself makes it possible to analyse the relationship between the two systems. In this, I follow the example of those who build upon the distinction made by Karl Marx in his *Grundrisse* written as early as 1857, where he defined the notion of production in these terms: "All production is appropriation of nature on the part of an individual within and through a specific form of society" (Marx 1939: 21). For Marx, the act of production was inevitably to be found at the juncture of two systems: the system of relations between an individual and nature, and the system of relations between individuals within society (see also Debeir et al. 1991: xiii). An alternative approach, terminologically different but analytically equivalent, would be to define energy systems

as a single sociotechnical-metabolic system that includes both societal and biophysical aspects into a single system, and then to isolate the biophysical system that consists of the natural energy sources, conversion, and uses from those other dimensions. For both clarity of terminology, and for consistency with analysts ranging from the early Marx to Smil, I have chosen the simpler approach of defining 'energy systems' in terms of the purely biophysical characteristics, and consider the social, technical, political, mental and other dimensions as separate empirical objects with which that biophysical system interrelates.

Adopting terminology originally due to the ecologist Alfred Lotka (Debeir et al. 1991: 4, 240), Smil further distinguishes between conversions that are performed by biological organs and hence 'endosomatic' and those that are performed outside the body by tools or machines and so 'exosomatic', writing that the "Existence of the earliest hominin foragers was not that different from the survival of scavenging omnivorous animals as their somatic energy (conversion of food into muscle power) was just a segment of naturally cascading energy degradation beginning with solar radiation and ending with the dissipation of heat during walking, running, and gathering food", and suggesting that the first deliberate extrasomatic energy conversion may have been the mastery of the control of fire nearly 800,000 years ago (Smil 2010: 1). The exosomatic use of fire and firewood, as well as other exosomatic tools for cutting and hunting animals and for obtaining and processing plants allowed

early human ancestors to 'externalise' their digestive processes, ensuring that otherwise hard to digest, inedible, and even poisonous materials could be made safe to eat, reducing the endosomatic energy required for digestion, and creating the conditions for the physical and cultural changes that distinguish humans from other animals (R. Wrangham 2009). In contrast to animal and early hominin foragers, then, human energy systems are characterised by exosomatic conversions (Debeir et al. 1991, Smil 2010, R. Wrangham 2009).

The environmental historical Rolf-Peter Sieferle conceptualises human societies into three distinct socio-metabolic modes or regimes: hunting and gathering (or 'hunter-gathering'), agrarian, and industrial (Sieferle 1982, Fischer-Kowalski and Schaffartzik 2015: 3). In the hunter-gatherer mode energy is gained from the products of photosynthesis either directly through gathering wood or vegetable food or indirectly from the hunting of animals, an energy system that may be described as 'passive solar energy utilisation' (Fischer-Kowalski and Schaffartzik 2015: 3).

In the agrarian sociometabolic mode, the energy system is 'active solar utilisation' in which cultivated crops and fodder and domesticated animals actively harness solar energy, a mode that typically requires more sedentary settlement patterns than is typical of hunter-gatherers. These systems are 'active' in the sense that they consist in manipulating terrestrial ecosystems so they yield biomass for humans to use, manipulations that allow agrar-

ian societies, on average, to metabolise energy and materials at three or four times the rate of hunter-gatherers (Fischer-Kowalski and Schaffartzik 2015: 4-5). Agriculture is estimated to provide around 90 percent of the energy obtained by agrarian societies; though inanimate converter technologies like sails, water wheels, and windmills would later be used across agrarian societies, they would never supply a significant proportion of energy when compared to human or animal muscle (Krausmann et al. 2008: 188, Smil 2010: 51).

The industrial mode, then, for the first time represents a significant use of inanimate converters, largely based on the combustion of fossil fuels in engines and turbines, significantly surpassing the amount of work done by human or animal muscle (Smil 2010: 48-60). This heavy use of nonbiomass fuels, particularly coal, oil, and natural gas, partially relieves societies from their immediate dependence on land for food and fodder, and allows unprecedentedly high levels of urbanisation (Motamed et al. 2014, Fischer-Kowalski, Krausmann, et al. 2013). In the twentieth century nuclear fuel became increasingly used for electricity generation, providing about 15 percent of the world's total energy in 2005; that same year, hydropower provided about 17 percent of the global total, and renewables about 2 percent, mostly from wind turbines (Smil 2010: 39).

From an evolutionary perspective, most physical traits are adaptations that increase an organism's ability to obtain and retain energy from its environ-

ment (Eldredge 1995, Stoelhorst 2007: 239-240), so it is at the very least a plausible working assumption that cultural traits might be similarly adapted to making the most of the available energy resources. It has been hypothesised that though animal foragers have evolved an instinct to maintain their possession of resources (J. M. Smith and Parker 1976; J. M. Smith and Szathmáry 1997; Kokko, López-Sepulcre, et al. 2006; Alcock 2005; Krier 2009; Stake 2004; Gintis 2009), hunter-gatherers generally adopt communal ownership institutions and share resources fairly equally; and whilst agriculturalists and pastoralists typically live under more hierarchical command ownership institutions, contractually defined titled property has become widespread in societies that rely heavily on fossil fuels (Krier and Serkin 2015, Boehm 1999, 2004, Heinsohn and Steiger 2013, Lau and Smithin 2002, Strunz et al. 2015). The need for a better theory to explain this coincidence between energy resources and ownership institutions is remarked upon by researchers across disciplines, with anthropologists noting that "Rights to property ownership vary by culture and by resource type ... How these rules and norms came to exist, how they are maintained and enforced, and how they change over time is a fruitful direction for future research" (Gurven and Jaeggi 2015: 6), economic historians describing the adoption of farming as "a cultural as well as technological revolution, requiring a new system of property rights" (Bowles and Choi 2013: 8830), and development economists writing that "The general confusion between property and possession and the rarely understood differences between mineral and living resources have opened the way for more or

less naive discourses on sustainable development. Therefore, a new theory integrating these multiple differentiations is badly needed" (Steppacher 2008: 351).

1.3 Research question

Addressing these fundamental questions, of how ownership rules and norms came to exist, how they are maintained, and how they change, are the primary aim of this thesis. My approach has been to interpret these questions in evolutionary terms, and to construct an evolutionary model to suggest why certain variations in behaviour are more likely to survive and be reproduced in some settings than in others. Once constructed, I then interpret this model to suggest ways in which the different characteristics of energy resources might lead to different institutional outcomes. I then assess the plausibility of my interpretation of the model against the available historical evidence for the circumstances in which the last of these institutions, titled property, has actually evolved.

So, the general question I ask in this thesis is: why do different ownership institutions tend to survive to govern different energy resources? Within this broad scope, and bearing in mind that my motivation is to find a framework for better understanding how our current institutions might change in the future, the main empirical focus in this thesis is on the evolution of the most

recent of these. The central research question in this thesis, then, is: *what are the characteristics of the energy resources of a society in which titled property institutions tend to survive?*

1.4 Thesis overview

Following this introductory chapter, in chapter two I review the existing literature on the relationship between energy systems and social, political, and economic institutions. Though rich and varied, this literature has yet to incorporate the insights from recent scholarship that draws out the important distinctions between the different ownership forms, as discussed above. Lacking these important conceptual distinctions, I suggest, the literature has long struggled to provide a plausible mechanism for the way in which the different characteristics of energy resources might affect these wider social, political, and economic structures. This thesis is my attempt to fill that gap.

In chapter three, I propose definitions for the institutional outcomes to be modelled as ideal types, namely 'possession', 'communal ownership', 'command ownership', and 'titled property'. There is a wide variety of work on ownership institutions conducted by researchers across the humanities and social sciences, and very little consensus on the meaning of different terms. In arriving at my definitions, I structure the chapter around the many different ways in which different ownership institution have been theorised to

survive to govern different kinds of resource, and use those theories as a basis for determining how to define those institutions that have survived to govern the different energy resources that are the focus of this thesis. In addition to providing conceptual clarity, an independently important result emerges from this chapter, since my interdisplinary work suggests that across the different disciplines scholars are engaged in disputes that all seem to derive from a neglect of the important difference between resource stocks and resources flows. The taxonomy I propose, of defining possession, communal, command, and titled property ownership in terms of rules governing resource *flows* provides much needed conceptual clarity and helps resolve several long running disputes across a number of different disciplines.

In chapter four, I present a second literature review that critically surveys the scholarship as it attends to the theories of ownership change as they relate to wider economic, social, political, and technological transformations, noting that across literatures there has emerged a tendency to conceive of changes as complex, and to distrust unicausal models. I examine the literature surrounding the transitions to communal, command, and titled property institutions in turn.

In chapter five, I build on the intellectual space opened up in the previous chapter by presenting a third literature review discussing theories of institutional change more widely. Two such approaches – rational choice institutionalism and historical institutionalism – have long been used to explain

institutional changes, with a third approach, evolutionary instituitonalism, recently developed as a result of criticism of the two older approaches. The chapter then establishes the 'building blocks' of an evolutionary analysis of ownership change, and sets out the literature on the specific evolutionary game theoretic modelling approach adopted in the following chapter.

In chapter six, I construct the evolutionary game theory model and defend its main assumptions. I begin with initial assumptions very similar to existing models of the evolution of possessive instincts in animals. To these initial conditions I add a minimal number of additional parameters in order to model the way in which the characteristics of different energy resources might result in different institutional outcomes. Intepreting the model, the chapter ends with a set of claims about the energetic circumstances in which different ownership institutions are likely to survive. The first of these claims is that an 'ideal type' possession institution might survive when resources are too small to be worth fighting over and the benefits of sharing with others in the group are small. The second of these claims is that communal ownership institutions are more likely to survive when resources are too large for possessiveness to prevent conflict, and where the unpredictability of resources means that individuals who mitigate risk by sharing are more likely to survive. The third of these claims is that command ownership institutions are likely to survive where resources are predictable and localised, so that more powerful individuals are able to extract resources from subordinate individu-

als who have few opportunities to escape. The fourth and final claim is that titled property institutions are more likely to survive when a society's energy resources are growing, as individuals are motivated to enter into titled property contracts by the promise of returns that can typically only be realised where energy resources are expanding.

A long seventh chapter traces the evolution of titled property institutions. Beginning in ancient Mesopotamia, where property titles originated in commercial loan contracts, I outline the evolution of titled property through ancient Greece, republican and imperial Rome, the European Middle Ages, and into the modern period, focussing particularly on the gradual reemergence of titled property in medieval and early modern England. Throughout this narrative I analyse the way in which titled property has only been able to survive when there is a growing energy base, typically in the form of territorial expansion, but later, also in the form of fossil fuels. Where expansion of the energy system cannot supply the economic growth required by the aggregate of individual interest repayments across a non-shrinking population, the result throughout history has been a cycle of recurring debt crises and the dispossession or even enslavement of defaulters.

In chapter eight, I discuss the distinctive contributions of the thesis, the controversies with which they are embroiled, and the future work required to help resolve those controversies, and in a short final chapter, I draw the thesis to a conclusion.

Chapter 2

Literature review 1: energy and society

Introduction

In this chapter I review the literature theorising how the energy resources used by a society might be related to the institutions of that society. Helped considerably by previous reviews (Rosa et al. 1988, Mirowski 1988, 1991, Smil 2008, 2010, Moellers and Zachmann 2014), the chapter proceeds approximately chronologically, and draws on the major contributions to theories of energy and society from across a number of academic disciplines. Two themes recur throughout this long literature. The first is the question of what relationship natural laws have to the theories of social science; the scholars

whose work is cited here all maintain that there is a relationship between the material circumstances of a society and its institutions. The second recurring theme is that though these theorists all identify a correlation between energy resources and social institutions, the mechanism by which social change occurs as a result of the adoption of new energy resources has yet to be clearly articulated; that is the gap that this thesis is intended to fill.

Some may argue that there is nothing unique about the energy-ownership relation, rather that the ownership of energy is merely one example of the changing forms of ownership and control that have been a consequence of the broader transformations in socio-economic, political and technological arrangements that have characterised human societies for millennia[1]. The argument of this thesis is guided by the hypotheses proposed by the long line of scholars reviewed here who argue that, whilst energy systems are not the only aspect of nature with which humanity relates, they are typically the aspect of nature which places the most severe limitations on human societies; that changes in the physical energy system have often been accompanied by wider socio-economic, political, and technological changes; and that the social sciences have largely failed to recognise that all forms of socio-economic activity require the use of energy. I work on the hypothesis that these are important insights, and that the relationship between energy and the ownership institutions that govern its flows are, therefore, at the very least worthy of further investigation.

[1] I thank my examiners for making this point.

I begin the chapter by sketching how, in the late nineteenth and early twentieth centuries, energy became better understood in the natural sciences, and as a result early social theorists began to theorise about how the use of different energy resources might relate to the observed variations between different societies. In section two, I review key works from the mid-twentieth century, when focus on the importance of energy limits, and the social consequences of reaching those limits, intensified. In the third section, I review the work of theorists from the late twentieth and early twenty-first centuries as they continue to investigate the question of why wider changes in norms and institutions accompany the transition to different energy systems, and what this might mean for the future evolution of societies. A short final section concludes.

2.1 The early research into energy and society

By the mid-nineteenth century, developments in physics began to allow a far greater understanding of energy and its role in human society. How little was previously understood is nicely illustrated by the fact that it was not until 1853 that the sun was first identified as the principal source of energy available to humans (Thomson 1853). A series of influential social theories of energy and society were developed in the decades that followed. In

1862, the polymath Herbert Spencer reasoned that since energy was required for doing work, differences in energy use would account for many of the material differences between societies, and suggested that a society would do better the more energy it could capture (Spencer 1880). Along similar lines, in 1881 Edward Sacher, a little known Austrian science teacher, described economies as systems for obtaining the largest amount of energy from nature, and began to correlate 'cultural progress' with per capita availability of fuel (Sacher 1881). Also in the early 1880s, Sergei Podolinsky interpreted Marx's suggestion that technological changes from hand power to steam power or to machine tools had brought about the transition from feudal society to industrial capitalism, even going so far as to argue that energy, not labour, was the principal source of economic value (Podolinsky 1880).

In 1887, another schoolteacher, Georg Helm, published *Die Lehre von der Energie* (Helm 1887). Though the book was largely concerned with physical theory, it also included a chapter extending the theory of energy to social theory, particularly economics. In this chapter, Helm was perhaps the first to note that the then newly emerging neoclassical economists had failed to properly acknowledge the importance of the conservation of energy in their work. An even closer connection between energy and culture was claimed by Leon Winiarsky in turn of the century Switzerland, who argued that physical value and social value were actually identical and governed by a single set of natural laws (Winiarsky 1967). In the same vein, the sociologist

Patrick Geddes developed a historical framework based upon the distinction between coal-based and electricity-based energy systems, suggesting that this energy transition had been accompanied by "qualitative progress, expressed in terms of skill and art, of hygeine and education, of social polity, etc." (Geddes 1906).

Avoiding quite such a simplistic reduction, the chemist William Ostwald (Ostwald 1909) continued to develop the idea that 'societal progress' might rely upon increased energy use, since this allowed energy surpluses to be put towards cultural development. German engineers developing electricity generation at that time drew on Ostwald's arguments to justify innovations which minimised the waste of energy in conversion processes, and even argued that the efficiency of a system should take precedence over its profitability (Moellers and Zachmann 2014: 16). In 1921 Thorstein Veblen proposed a similar arrangement for the United States, arguing that engineers were better placed to manage an industrial system than what he described as 'vested interests' (Veblen 1921); similar considerations later motivated the 'scientific management' of Frederick Taylor and the Technocracy movement of the 1930s (Mirowski 1988: 815). However, in an oft repeated criticism of Ostwald, Max Weber attacked Ostwald's attempt to reach sociological conclusions from empirical natural scientific observations, as well as for his apparent neglect of thermodynamic principles and for assuming abundant energy (Weber 1909: 37-38). But given the focus Ostwald had given to

energy limits, and to the importance of energy conservation in what he later dubbed 'the energetic imperative' (Ostwald 1912), much of Weber's criticism seems misplaced. Indeed, Weber's opposition has since been interpreted as part of the effort by early social scientists to try to establish a field of research entirely independent of the natural sciences (Sieferle 1982: ix).

The work of another chemist, nobel laureate Frederick Soddy (Soddy 1912, 1922, 1926), was similarly attacked and thus largely neglected by social theorists of the time, despite that fact that he had been even more careful to frame his work in terms that more mainstream social scientists might find acceptable. Emphasising that social life could not be reduced to energetic considerations, Soddy nevertheless argued that an understanding of energy underpinned social science, writing that "[t]he laws of energy under which men live furnish an intellectual foundation for sociology and economics ... They do not give the whole truth, but, in as far as they are correct to physics and chemistry they cannot possibly be false" (Soddy 1922). He also emphasised the importance of the limit in the amount of energy that is available for human use, ultimately advocating a transition from scarce fossil fuels to nuclear energy, although nuclear power was still decades away from realisation (Soddy 1920: 22-24). Predicting that the existing economic system would impede the transition away from fossil fuels, Soddy advocated for an economic system consistent with the laws of thermodynamics to at least make the transition possible (Soddy 1926: 49-68).

Around this time, two other well known scholars also attempted to argue for deliberate changes to the political economic system on the basis of the importance of energy to society. Economist T. N. Carver (Carver 1924) studied the way the energy of the sun was transformed for human use by energy systems, and noticed that whilst all living organisms capture energy from these transformations, humans were able to accumulate increasing *surpluses* of energy. These surpluses, he reasoned, powered economic and societal changes, further arguing that 'moral capitalism' was the best economic system since it wasted the least energy. Lewis Mumford (Mumford 1934, 1967), however, used a similar logic to Carver to reach a contrary conclusion: building on Veblen's analysis of inefficiency, and expanding Geddes's historical framework, Mumford argued that whilst energy had been correctly identified as the foundation of societal change, social values were important in ensuring that newer and more efficient technologies would be adopted, and so argued that the communal values of communism were required to ensure energy surpluses would be maintained.

The anthropologist and sociologist Leslie White (White 1943, 1959) is credited with renewing the study of the relationships between energy and society by removing the teleological arguments of many of his predecessors. He placed energy firmly at the centre of his cultural theory, stating at the very start of his seminal 1943 paper that "[e]verything in the universe may be described in terms of energy. Galaxies, stars, molecules, and atoms may be

regarded as organizations of energy. Living organisms may be looked upon as engines which operate by means of energy derived directly or indirectly from the sun. The civilizations, or cultures of mankind, also, may be regarded as a form or organization of energy" (White 1943: 335). White saw technology as the driver of changes in energy transition and by extension of societal transitions, and noted that great civilisations in the past had failed to advance after an initial period of rapid increased energy capture. The recognition that fossil fuels were limited led him, like Ostwald, to express optimism for the potential of nuclear energy (White 1943: 350-1). In terms of the effects of energy transitions on society, White reaffirmed the notion introduced by Sacher almost 70 years earlier, that energy surpluses are key to cultural evolution, writing that "culture evolves as the amount of energy per capita per year is increased, or as the efficiency of the instrumental means of putting the energy to work is increased" (White 1943: 366). Though recognising that this relation might be complicated by other factors (White 1943: 338), he nevertheless expressed this relationship as a simple mathematical function equating a society's level of cultural evolution to the product of its per capita energy and the efficiency of its conversion, again fuelling criticisms of reductionism and of neglect for the importance of energy limits.

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2.2 A renewed focus on energy limits

Unlike White, the political scientist Fred Cottrell placed energy limits at the very foundation of his theory. The very foundation of his book, *Energy and Society* (Cottrell 1955), was the simple premiss that the range of possible human activities is limited by the quantity of energy that is available to perform them. Using historical examples, he argued that a wide range of social, economic, political, and even psychological changes accompanied the transition from low-energy using societies to high-energy using societies. Like many of his predecessors, Cottrell noted how differences in energy surpluses had often led to differences in political power, as well as describing the effect that localised resource depletion had often had on world events, giving as a particular example the contribution of the decline in soil fertility during the Roman empire to trade and warfare across the Mediterranean. Although Cottrell suggested that cultural values were the driver of these cultural changes, the anthropologist Marshall Sahlins was quick to point out that such an argument was circular, since cultural values were themselves the produce of the cultural changes that had occured (Sahlins 1956). Cottrell had himself conceded that "perhaps the chief contribution of this essay lies chiefly in the fact that it suggests whole areas of ignorance whose exploration might increase the accuracy of thinking about the future development of human society" (Cottrell 1955: 311). Nevertheless, the book contained several detailed expositions of societal changes coinciding with energy transitions,

and introduced and clarified a number of important concepts, notably the concepts of low-energy and high-energy society and the use of the ratio of energy return on energy investment, or 'EROI', to express the amount of energy input required to obtain a further amount of energy.

Beginning a period in which anthropologists turned away from grand energetic theories to engage in more detailed, smaller scale studies, a seminal study by anthropologist Clifford Geertz (Geertz 1963) examined in detail the specific processes of how changes to energy flows combined with local ecology and cultural domination during the energy transition brought about by the imposition by the Dutch of plantations on two older indigenous systems of agriculture. Other field researchers, sometimes described as the 'community ecology' movement (R. N. Adams 1978), renewed their efforts to compile detailed time and energy budgets in order to better understand the relationships between energy systems, social structure, and social change. Integrating the data from these studies, as well as older evidence reinterpreted in energetic terms, allowed these societies to be better compared to each other. In one such study, anthropologist Richard Adams (R. N. Adams 1975) suggested that these empirical results stongly supported one of Spencer's early theories: that one effect of energy upon social structure was that to reach a higher level of social power, a society needed to be in control of more energy. Elsewhere, Marvin Harris (Harris 1971, 1979) examined the energy returns on various energy converting strategies using a variation of Cottrell's concept

of 'energy return on energy invested' (EROI). That energy resources had important consequences for society was finally gaining widespread acceptance, a fact nicely illustrated by the publication of a special volume of *Scientific American* in 1971 on the subject of 'Energy and Power', which included articles tracing the flow of energy through the biosphere (Kemp 1971), through a hunting society (Kemp 1971), through an agricultural society (Rappaport 1971), and through an industrial society (Cook 1971). Tellingly, that volume also included an article by the geologist and geophysicist M. King Hubbert estimating the quantity of energy resources of the Earth, and estimates of when fossil fuel reserves were likely to become depleted (Hubbert 1971).

Also keenly aware that fossil fuel reserves are not limitless, the economist Nicolas Georgescu-Roegen (Georgescu-Roegen 1971) similarly argued that the problem of energy limits had been ignored by orthodox economic theories of limitless growth. Noting that whilst sustained periods of economic growth had shaped modern societies, he argued that reaching these limits would inevitably result in fundamental societal change. This idea that the physical limitations of energy resources meant that unrealistic expectations of limitless growth would bring societal crises was further developed by ecologist Howard Odum (Odum 1973) and ecological economist Herman Daly (Daly 1972, 1974, 1974). Odum and Daly developed Georgescu-Roegen's influential arguments for a steady-state economics that did not rely on the unrealistic assumption of limitless growth, with Daly editing an influential anthology entitled *Towards*

a Steady-state Economy (Daly 1973[2]). Daly credited John Stuart Mill with the idea of a steady state economy, but virtually all classical economists, including Adam Smith, David Ricardo, and William Stanley Jevons, had hypothesised that economic growth would eventually stabilise into a non-growing steady-state (C. A. S. Hall and Klitgaard 2012: 125-127).

Physicist Amory Lovins (Lovins 1977) similarly examined the trajectory of high-energy contemporary societies, also concluding that the existence of energy limits meant that the current use of energy resources could not continue indefinitely. He further argued that even massive technological developments of the kind that had evolved in response to previous energy crises would not solve the problem but merely displace it, and proposed that the cycle of crises could instead be avoided by the adoption of alternative energy sources and the adoption of less wasteful energy systems. Lovins argued that this would involve a shift from supply-side economics focused on production to an end-use based approach to economic needs that determined "how much of what kind of energy is needed to do the task for which the energy is desired, and then supplying exactly that kind" (Lovins 1977: 8). This deliberate shift to lower energy use, described by Lovins as 'the soft path', would imply a complete restructuring of society but suggested that a less energy intensive society could also yield a higher quality of life. This view was supported by research, then and since, showing that up to a certain point increases in energy consumption are closely related to increases in indicators of wellbeing

[2]Revised and republished under different titles in 1980 and 1983.

such as health and education, but that beyond that point increases in energy use no longer lead to clear increases in wellbeing (see Steinberger and J. T. Roberts 2010, Trainer 2014 for reviews). Morrison and Lodwick (Morrison and Lodwick 1981) further suggested that a transition from a high-energy to a low-energy society might also include less centralisation, a smaller scale of social organisation, and less exploitation of rural sectors by urban elites, since de-intensification could be expected to reverse effects of those processes that accompanied societies becoming more energy intensive.

2.3 Energy, evolution, and the future of civilisation

Similarly motivated by a desire to understand the effects that a future energy transition might have on society, environmental historian Rolf Peter Sieferle undertook a long view of the past relationship between energy systems, industrial revolutions, and social evolution (Sieferle 1982). Originally writing in the context of debates in Germany in the 1980s over the different social consequences of a nuclear or solar based post-fossil fuels future, his aim was to "assess the truth of whether the character of an energy system determines future paths of social evolution" (Sieferle 1982: xi). Consciously building on the earlier work of the 'community ecology' anthropologists, Sieferle conducts an ecological history of the relationship between energy systems and

social evolution, though he does not articulate a clear mechanism for the way this evolution occurs. His empirical work begins with short analyses of the way that earlier social evolution during the paleolithic and neolithic had been adaptations to the energy systems of those societies, and his main empirical case is the depletion of wood in Europe in the 18th century and the changes that took place during the industrial revolution. Emphasising that "historical processes have a foundation in natural processes, which human agents cannot eliminate at will, and that they play a role in shaping events and moulding structures" (Sieferle 1982: vii), he suggests that real alternatives to fossil fuels have not yet become even remotely apparent, and that, as such, "[t]he exhaustibility of energy resources remains a sword of Damocles hanging over the industrial system" (Sieferle 1982: 203).

Historical cases in which previous societies exhausted their resources are also the focus of Joseph Tainter's *The Collapse of Complex Civilisations* (Tainter 1988). In that book, Tainter developed Cottrell's concept of the ratio of 'energy return on energy invested' (EROI), to argue that declining returns on increasing societal complexity led to the collapse of eighteen historical societies, including Rome, the Western Chou in China, the Maya and the Chacoans of Mesoamerica, and the Eastern Woodlands civilisation of north America. As energy became more difficult to obtain, he argues, the energy return on energy invested (EROI) decreased, the energy base of those societies became less and less sustainable, and the civilisations became increasingly

vulnerable to collapse. Tainter notes that a variety of energy related activities have diminishing returns, including both agriculture and fossil fuels, and he argues that there is no reason to believe that industrial society is not subject to the same principles that caused earlier societies to collapse. He notes, however, that in the past some cases of resource depletion were followed by periods of intensification and expansion, whereas in other cases they resulted in collapse. Noting that some economic theories suggest that diminishing returns can be eventually overcome by technological developments, Tainter argues that one explanation for the two vastly different outcomes is that in some circumstances technological innovation allows expansion. However, he cautions against the more optimistic predictions for the fate of industrial society, noting that historically the development of technological substitution has not always been possible, and where it has taken place such technological transitions have taken a long time and deflected resources from elsewhere. Drawing parrallels to current arguments in favour of a return to a lower energy society, Tainter suggests that, historically, societal collapse and a reduction in complexity represents just one possible adaptation to the decline in available energy: "*under a situation of declining returns*" he writes, "*collapse may be the most appropriate response.* Such societies have not failed to adapt. In an economic sense they have adapted well – perhaps not as those who value civilizations would wish, but appropriately under the circumstances" (Tainter 1988: 198, emphasis in original).

That previous energy transitions have been long drawn out processes is borne out by the quantitative and historical work of energy analyst Vaclav Smil (Smil 2008, 2010, 2016). Like others, he finds that, given the central importance of energy for economic processes, "it is incredible that energy has never been a primary, not even a major, concern of modern economic inquiry" (Smil 2010: 13). In his work, he sets out the broad history of energy transitions throughout the last 800,000 years, integrating the history of transitions in energy resource, technological development, and changes in energy use, based upon his previoius research in which he compiled and analysed extensive sets of energy data and detailed case studies. Though his focus is on technological history rather than institutional change, he finds that though all historical energy transitions eventually led to improvements in quality of life, they have also all been the cause of "major socioeconomic dislocations", changing both habits and infrastructures of production and transportation (Smil 2010: 150).

The most recent book-length work to specifically focus on the institutional changes brought by energy transitions, Ian Morris's *Forager, Farmers, and Fossil Fuels* (Morris 2015) examinines the interaction between ways of capturing energy, social relationships, and ethical values. Drawing together a large cross-section of recent historical, archaeological, and anthropological literature, his main argument is that over the last 20,000 years the predominant value system of a human society has been determined by that society's

institutions, which are in turn determined by that society's means of capturing energy from the world. As one reviewer notes, Morris's book is the first attempt at a general conceptual model of the interaction between material conditions, social institutions, and value systems since Karl Marx and Adam Smith (Bisin forthcoming: 4). Also notable is that he disagrees with many institutional theorists who tend to view institutional change as the endogenous driver of technological change (North and Thomas 1977, North 1990, Greif 2006, Acemoglu and J. A. Robinson 2012, for example); conversely, Morris argues that the methods that a society has of capturing energy are what determine its institutions, suggesting that an evolutionary process is at work in which different institutions are more likely to survive in some energy settings than in others. However, as more than one reviewer notes (Hanson 2015, Bisin forthcoming), whilst Morris provides repeated examples of the correlation between energy resources and institutions, he does not provide any account of the mechanism by which the selection of institutions takes place. The purpose of this thesis, then, is to try to fill that gap.

Conclusion

Since energy became better understood about 150 years ago, theorists from a variety of disciplinary backgrounds have attempted to understand why societies with different methods of extracting and using energy from their

environment also tend to have different institutions. At the beginning there was resistance to the idea that the material conditions of a society might play a role in its social and cultural institutions, but a long literature of historical and anthropological case studies have repeatedly shown that societies with similar resource bases do, in fact, tend to resemble each other with regard to their institutions. As a result, the scholars cited in this literature review have all taken the view that the striking correlation between energy systems and social institutions is in need of explanation, and that there may be an evolutionary process at work. However, just how this evolutionary mechanism operates has yet to be articulated. Since ownership institutions are the rules by which resources are transferred between members of a society, understanding the evolution of ownership is, I suggest, central to explaining the relationship between natural and social systems. My next step, in the next chapter, is to define the different ownership institutions that have been adopted by different societies over the course of history.

Chapter 3

Concepts of ownership

Introduction

Given the central importance of ownership institutions to human society, it is unsurprising that every discipline within the humanities and social sciences has been host to debates about how ownership should be conceptualised. This provides richness, but also the potential for confusion. My first aim in this chapter is to trace the commonalities between some of these key debates, helping to identify areas where one body of theory might be made more comparable with the work of scholars in different disciplines, and to see where lacunas in one disciplinary debate might be filled by work done in other disciplines. My second aim is to examine one striking commonality that has emerged from my comparison of these different debates: the fact

that the source of many of these diverse disputes seems to be the neglect of a fundamental distinction between resource stocks and resource flows. It is by defining this distinction that I begin.

3.1 Fund-services, resource stocks, and resources flows

Different resources have different characteristics. A fundamental distinction has been made between those resources that are stock-flow resources and those that are fund-service resources (Georgescu-Roegen 1971, Daly and Farley 2011: 71-73). Stock-flow resources are physically transformed by their use, for example when a tree is transformed into ash, heat, and smoke by combustion. Because they are physically transformed by their use, stock-flow resources are used up in the act of production; in economic jargon, they are subtractable and depletable. The rate at which stock-flow resources are used is not determined by their physical characteristics: a forest can be cut down very quickly, or can be harvested at a very slow rate. Importantly, we can divide between the stock and the flow of a resource, with the stock referring to the quantity of that resource, and the flow referring to the rate at which units are extracted. Like capital, a resource stock can produce a flow of income; but if the flow is at too high a rate for it to be replenished, then the stock will be depleted. Energy resources, particularly, are all stock-flow

resources, since they are consumed by their use. Flows such as meat, dairy, crops, and lumps of coal are extracted from stocks of animal herds, livestock, agricultural land, and coal mines. Typically, energy stocks on Earth are replenished by the flow of energy from the sun, where the fusion processes converting mass into energy initially takes place.

Fund-services, on the other hand, are a specific configuration of stock-flow resources; a car, for instance, is a specific configuration of glass, metal, plastic, and rubber. Though they may be worn out a little, fund-services are not physically transformed by their use, and can only be used at a given rate: a car, for example, cannot be used to carry more people than it can physically contain. A fund-service resource can be converted into a stock-flow resource if it is used, not for the services provided by its configuration, but by transforming the physical materials that the resource provides, for example when the material from a car is reused as a stock-flow resource in a scrap yard, and the rubber and plastic are even burnable as fuel. Fund-services like lighthouses, the ozone layer, or picturesque views are not the original source of energy flows, in these cases flows of light, but they are the means by which the physical qualities of that light are altered, whether in the direction that it shines, the frequency at which it shines, or in its conveyance of scenic beauty to the eye of a beholder. Similarly, the fund-service of an organised police force does not itself detect or deter crime, but it does direct the flow of human energy and other resources to provide police officers that

can carry out that work. Fund-services may be costly to provide initially, but since they are not transformed by their use, they can provide benefits to many different people (Farley 2012).

3.2 Private, public, common, and club ownership institutions

This fundamental physical distinction between fund-services and stock-flow resources is an important starting point for understanding the way that different resources have come to be governed by different ownership institutions. The theory of public goods[1] initially developed by Paul Samuelson is based on the concepts of 'excludability' and 'rivalry'. An excludable resource is one where others can be excluded from using the resource; a non-excludable resource is one where they cannot. A rival resource is where one person's use of that resource prevents simultaneous use by another. Rivalry is also referred to as subtractability, and is described in economic terms as a resource for which there is a marginal cost for providing it to each marginal user.

[1] In standard economic theory, the difference between a good and a resource is that a resource is something used to produce a good, and a good is a material that satisfies human wants (Milgate 2008: 706). But this means that before a thing is actually used it is impossible to say whether it is a good or a resource, since materials can be used both directly and indirectly to satisfy human wants: a piece of coal, for example, would be a resource when burned to produce electricity for heating, but a good if burned for the same purpose in a fireplace. In this chapter, then, I use the two terms interchangeably, simply following the usual usage in a given context.

In the jargon: nonrival resources are where marginal costs are zero. It is usual to represent these resource characteristics as dichotomies, resulting in four discrete categories: private goods are excludable and rival; public goods[2] (sometimes called 'pure public goods') are non-excludable and nonrival; common pool resources are non-excludable but rival; and club (sometimes called 'toll' goods are nonrival but excludable and so named because only those who are members of the club, or those who pay a toll, have access to them (see Ostrom 2005). Though it is possible for an institution to govern a kind of resource with which it is not usually associated, such arrangements are less likely to evolve and to survive: nonrival resources may be undersupplied unless provided by public or club institutions, and rival resources may be overused to the point of depletion and so are more likely to survive when governed by private or common institutions. In both scenarios, it is clear that if a resource does not exist then neither will any institution to govern it.

However, though the binary of excludability might sometimes be a useful heuristic, it is empirically and theoretically problematic. The principal issue is that the ability to exclude is not a characteristic of a resource, but a characteristic of the institutions that govern that resource. In recognition of this, modern economic scholarship instead tends to refer to the difficulty or

[2]I have found two occasions where the term 'public good' has been used by anthropologists to refer to a resource to which all members of a group have access (Hawkes 2001 and Gurven, Hill, et al. 2004: 544), but since this usage is rare, and in one of these cases inconsistent with her work elsewhere (Hawkes et al. 1991), these seem to be instances of unintentional misuse rather than evidence for a different disciplinary convention.

Table 3.1: Type of resource as categorised by binaries of excludability and rivalry

	Excludable	Non-excludable
Rival	Private	Common
Nonrival	Club	Public

The standard two-by-two table categorises resource characteristics as dichotomies and results in four discrete categories: private goods are excludable and rival; public goods are non-excludable and nonrival; common pool resources are non-excludable but rival; and club goods are nonrival but excludable.

cost of exclusion, though again it is important to note that the difficulty or costs of excluding somebody from using a resource is not purely a matter of the physical characteristics of that resource, but is in large part due to the institutional arrangements that have been adopted to govern that resource (Daly and Farley 2011: 73, Farley 2012). It is, for example, relatively easy and cheap to exclude somebody from using the light from a torch by keeping the torch in a padlocked cupboard, but this is only the case in a society where there are rules that make it easy and cheap to prevent other people from using things that you have kept locked in cupboards. On the other hand, the fact that it is difficult and expensive to prevent someone from using the light from the sun has little to do with the physical characteristics of sunlight, and much more to do with the fact that we live in a society that has outlawed slavery, creating a legal and social context that makes it really quite difficult indeed to keep people locked in cupboards. Conceiving of the excludability of resources, not in terms of the physical characteristics of the resource, but in terms of the institutional arrangements that govern those resources, is consistent

with the research that has been conducted into the actual governance of different resources. Noting that even though some commons scholars continue to reproduce the standard two-by-two table, Margaret McKean argues that commons really "should be classified just as we classify business partnerships, joint-stock corporations, and cooperatives" (McKean 2000: 30, 36). A similar argument may be made with regard to the distinction between club and toll resources: a public resource is simply a club resource with a membership so large that it includes all citizens as members.

Many economists have further suggested that the dichotomy between rival and nonrival resources is questionable and that a graded approach to rivalry is also more appropriate (see Leach 2004: 155-156). In the terms used above, the reasoning is that whilst stock-flow resources are absolutely rival, for example where a gallon of petrol cannot be used both for fuelling a car and for fuelling an aeroplane, many fund-service resources are nonrival up to a certain point, but that after that point the marginal costs increase. A usual example is the provision of public roads. For example, once a road is constructed then up to a certain capacity it is nonrival since an additional car driving on that road does not increase the costs of that road (the costs of maintenance are typically assumed to be negligible), but once a certain capacity is reached the road becomes congested, decreasing the ability of others to use it. However, the ecological economist Joshua Farley argues that nonrivalry should not be confused with abundance, suggesting that rather than forming a continuum,

the lack of abundance often has a fairly clear limit (Farley 2012). In some cases the limit is hard and abrupt; a car with five seats, for example, has a limit of five passengers, but in other cases, the limit is fuzzier. In the case of a road, for example, the physical space occupied by a car on that road is always rival, since only one car can occupy a given space at a given time, and as long as there is an abundance of additional spaces for additional cars the road has all the characteristics of a nonrival resource. But if more and more cars occupy more and more of the road space then road space becomes scarce and is less and less able to satisfy the road users' desire to move quickly from one place to another. When this occurs, for road space to become abundant again, an additional carriageway or an additional road may need to be constructed to increase the provision of the physical road space and so reduce the rivalry between road users. So although the benefits of fund-services are not depleted by additional marginal users, the number of additional users that can use a fund-service has a limit, and this limit is determined by the physical characteristics of the fund-service resource. Following this reasoning, the difference between what have previously been termed 'nonrival' and 'rival' resources is simply that in the latter the limit to the number of users has been reached.

The list of nonrival resources typically includes lighthouses and street lamps, the ozone layer, the provision of law and order, and sites of scenic beauty. These are all fund-services. Decisions to be made about the provision of

Table 3.2: Type of resource as categorised by a continuum of excludability and a binary of rivalry

	Range of excludability
Rival	From more private to more common
Nonrival	From more club to more public

In this modification of the standard table, resources are categorised as either rival or nonrival, and along a range of excludability depending largely on the institutions that govern them. All stock-flow resources are inherently rival; also rival are those fund-services that are not abundant. Rival resources may be categorised along a range of excludability, from more private to more common. Only abundant fund-services can be nonrival and are similarly categorised along a range of excludability, from more club to more public.

lighthouses and streetlamps include considerations about which ones to keep lit, which direction to point them in, and how brightly to shine them, so the desire of different potential users of that light is rivalrous with the desire of those who want that light to be directed in different ways. Different levels of ozone leave some parts of the world more dangerous to live in than others, and where these differences become extreme the protection afforded by the ozone layer becomes scarce and rival. As the provision of courts, of legal aid, or of the police is reduced, some members of the population are no longer as protected, and some crimes no longer detected or deterred in the same way as others, and so the provision of law and order becomes scarce and rival. And not everyone who wishes to appreciate sites of scenic beauty is able to do so simultaneously, for there is a limit to the number of people who can be within view of any given landscape. In each of these cases, when a formerly nonrival fund-service resource is no longer abundant, then one person's use of that resource prevents simultaneous use by another, and so access to that

resource becomes rival.

So: all stock-flow resources are inherently rival; also rival are those fund-services that are not abundant. Rival resources are more likely to survive if governed by institutions that fall along the range of excludability from more private to more common since these are likely to prevent their depletion, whereas only abundant fund-services can be nonrival and therefore more likely to be provided if governed by institutions that fall along the range from more club to more public. However, no distinction has yet been made between the stock and the flow of a stock-flow resource. To illustrate why this turns out to be problematic, I will next examine the effects that neglect of this distinction has had on the debates among legal scholars concerning the ownership of land, a resource stock whose ownership has long been taken as the paradigm form of ownership.

3.3 Absolute ownership and 'bundles of rights'

In the mid-nineteenth century, the broad consensus among scholars of the common law had been that the term 'property' referred to some thing, typically land but sometimes some other form of tangible resource, owned by an individual (Klein and J. Robinson 2011: 193-194). This view of ownership has been described in many ways, often with reference to the famous description by eighteenth century legal scholar William Blackstone as "the

sole and despotic dominion which one man claims and exercises over the external things of this world, in total exclusion of the rights of any other in the universe" (Blackstone 1765–1769: 2.1). Modern scholarship refers to this conception of ownership in different ways: as ownership *in rem* or 'over a thing' since its paradigm form is that of "a single human being owning . . . a single material thing" (Honore 1961: 107, 147); as 'dominion' since it allows absolute control over the thing that is owned (Klein and J. Robinson 2011: 194); as 'property-as-commodity' since such ownership makes an object tradable (Alexander 1997); as the 'exclusion view of ownership' since "owners have a right to exclude" (Katz 2008: 275, 281); as the 'ownership model' of property since the emphasis is on the relationship between the owner and the object (Singer 2008); and as 'full-blooded ownership' since it confers upon the owner the right to make any use of the thing, to exclude absolutely anyone, and to transfer the thing howsoever they choose (Underkuffler 2003: 12).

In the common law, this absolutist notion of ownership stems from the Middle Ages, when the most usual and simplest form of ownership in the English legal system had been that of fee simple absolute, whereby the king or queen granted an owner dominion over a piece of land (Blackstone 1765–1769: 2.4). Such ownership effectively amounted to a delegated sovereignty, so the essence of fee simple absolute is that it was understood as the ability to prevent anybody interfering with the resource so owned in any way. As

the dominant form of ownership, fee simple absolute reflected and reinforced the dominant idea of that time (and the view of most lay people ever since) that ownership was a relation between an owner and an object, with the owner's rights characterised by the fact that no-one except the owner had any rights to that land whatsoever. Towards the end of the nineteenth century, however, this idea of ownership as absolute dominion over land began to be criticised as outdated, and the notion that ownership should instead be understood as a 'bundle of rights' became popular amongst common law scholars. The 'bundle of rights' was used as a metaphor for the multiple rights specifying what the owner of a thing was allowed to do with it. This change in the understanding of the concept was provoked by the practical problem that the old absolute conception of ownership was not very useful for explaining how numerous different people could have rights to a single piece of land, since all or part of the land could be leased for a certain length of time, licences could grant access only to certain parts of it, and many other varied permissions and easements could give other people some kind of right to it. This was troublesome for the absolutist view of ownership, but ownership conceived as a 'bundle of rights' allowed a much clearer explanation of how such rights could be unbundled and how different rights to the same object could be held by different people (Klein and J. Robinson 2011).

There were also other benefits of the view that ownership could be conceived as a 'bundle of rights'. An early and influential contributor to the 'bundle'

conception of ownership was Wesley Newcomb Hohfeld who made much of the distinction between *in rem* rights held by a person with respect to a thing and *in personam* rights held by a person with respect to another person (Hohfeld 1913: 16, 1917: 710). With ownership no longer conceived as being the absolute ownership of a thing but as a 'bundle of rights' held by various different people, Hohfeld argued that it made sense to view ownership as rights held with respect to other people, and not as the relation between a person and an object. Again, such a conception helped to make sense of those legal realities that cannot be explained by a conception of ownership as the absolute ownership of a thing. For example, in the absolutist view, the enforcement of the payment of a debt would be thought of as a right in relation to a thing, that is, as the right of the creditor to take possession of the money that is owed to them. In practice, however, if a debtor dies then the creditor's right to the debt also expires. This cannot be explained if the rights of the creditor are understood as a simple relation between the creditor and the money, but makes much more sense if the right to enforce payment of a debt is thought of as a right that a creditor may enforce as a duty upon another person.

According to Laura Underkuffler (2003: 8), by 1978 few legal scholars would have disagreed when Macpherson wrote that "the current common usage of the word 'property' is at variance with the meaning which property has in all legal systems and in all serious treatment of the subject ... property is not

things but *rights*" (Macpherson 1978: 1-2, emphasis in original). Theorists began to turn their attention to the way that the varieties of rights could be bundled and unbundled (reviewed in Cole and Ostrom 2010). Given the potential variety of ownership arrangements no definitive classification seems possible but such taxonomies are nevertheless useful for describing different ownership systems. Among the best know example of such a taxonomical approach is common scholars Edella Schlager and Elinor Ostrom's categorisation of the five rights of ownership as access, withdrawal, management, exclusion and alienation (Schlager and Ostrom 1992).

Towards the end of the twentieth century, however, some theorists began to express dissatisfaction with the 'bundle of rights' view on the grounds that characterising ownership as a mere 'bundle of rights' turned ownership into a set of possible social relations, and so failed to distinguish ownership rights from any other kinds of rights. Some scholars, such as James Penner (1997), Richard Pipes (1999), and Larissa Katz (2008), made various attempts to resurrect the notion of ownership rights in terms of *in rem* rights held over an object. However, these approaches continued to suffer from the same problems as before, as they failed to offer a satisfactory analysis of the complex reality of ownership rights and relations where many people apparently hold a variety of rights in a single object, and some of those rights seem to relate to people rather than to the object itself (Mossoff 2011). Besides, as Robert Ellickson had previously noted, any position which took ownership

to be an *in rem* right over an object could easily be translated into a set of *in personam* rights with regard to other people, up to and including the point where Blackstone's absolute despotic dominion over a thing could be translated into a complete 'bundle of rights' that, taken together, would amount to the right to prevent everyone else from doing anything whatsoever with that thing (Ellickson 1991: 115, 1993: 1315, 1362-1363). Interestingly, one thing that is notably missing from the legal debate is a treatment of the instances when an owner has the right to destroy an object in their possession, in which case ownership is necessarily absolute. But even this extreme case can be translated using Ellickson's technique, rendering an owner who destroys an object they own into an instance of sombody exercising the right to prevent all other people from accessing that thing ever again.

An alternative to the attempts at resuscitating the *in rem* view was the approach proposed by scholars such as Kevin Gray (1991), Carol Rose (1994, 1998), and Gregory Alexander (1997), who argued that the problems of these extreme positions could be remedied by amalgamating the two opposing views into a position whereby ownership is seen as a relation both between people and with respect to things. For example, in his 1991 paper 'Property in Thin Air', Kevin Gray argued that the 'bundle of rights' approach to ownership may best be understood as the right to control which people have access to a thing. Gray's paper is well known as an argument against the *in rem* view of property as a relation solely between an owner and an

object, but Gray's argument also significantly departs from the 'bundle' view by arguing that all the various rights to ownership that scholars have categorised as being part of the 'bundle' could all be reduced to a single right: the right to control who has access to a thing. For example, the five categories of rights suggested by Schlager and Ostrom are access, withdrawal, management, exclusion, and alienation. Following Gray's reasoning, each of these rights can be reduced to the right to control other people's access to a resource. The right to control access is, of course, already the first listed by Schlager and Ostrom, and this right to control access implies the next three rights in their list, since controlling who has access to the resource implies control of who can make withdrawals from it, who can manage it, and who is excluded from it. These rights may most simply be conceived as the rights to control certain flows from a resource stock. Their fifth right of ownership is that of alienation which is the second order right to control access, as it is the right to assign through gift or exchange the right to control access; in other words, the right to alienation is the right to sell or give away the right to control other people's access to a thing.

The debate within the common law scholarship has, now, reached broad consensus. Various formulations that in some way synthesise the *in rem* and *in personam* positions are now widely adopted by legal scholars. Indeed, as Gregory Alexander found in his 1997 analysis, very few theorists in the history of the debates have ever actually held solely *in personam* or *in rem* views, as

most have in fact found it necessary to include both relations between people and relations between owners and objects in their accounts (Alexander 1997). The result is the now widely held view amongst legal scholars that ownership rights relate both to people and to objects. That this approach is the orthodoxy is nicely illustrated by the fact that the American Law Institute now defines 'property' as "legal relations between persons with respect to . . . things" (quoted in Underkuffler 2003: 12).

It is perhaps surprising that economic and political theorists – even these who are aware of those debates – still find themselves implicitly making assumptions based upon a notion of ownership as the absolute ownership of some thing. Economic and political theorists have been accused of paying little attention to the effects of law on their respective subject matters (Dagan and Heller 2001: 555), and even within the law-and-economics literature the analysis of property law has been, surprisingly, relatively neglected (Lueck and Miceli 2007: 249). More generally, as John Meyer suggests, "even critics whose subject is the inconsistency of absolutist property with practice appear to have difficulty conceptualizing an alternative" (Meyer 2009: 112). Reviewing historical cases and finding that in the last few hundred years of human history there are no instances of absolute ownership rights actually being practiced, Meyer notes that the attempts by legal theorist Thomas Grey and environmental philosopher Gary Varner to articulate a new conception of ownership are hampered by their historically inaccurate assumption

that things had, once, been owned absolutely. Curiously, theorists such as Harold Demsetz (1967), Douglass North and Robert Thomas (1977), James Krier (2009), and Francis Fukuyama (1992, 2011) make a similar assumption but reversed, as they narrate the evolution of ownership, and even human society as a whole, as a trend towards the establishment of absolute individual ownership over an ever greater number of things.

Whilst these things may all have contributed to the confusion, I suggest that the main reason for the difficulty theorists have had in conceptualising an alternative to absolute individual ownership is that they have completely neglected the crucial distinction between the ownership of resource *flows* and the ownership of resource *stocks*. The shift in legal thought, from a conception of ownership as dominion over some piece of real estate to a conception in which it is recognised that different individuals may have to rights to access different parts of that real estate, seems to me to be an attempt to reflect the distinction that occurs in practice between those who own the land and those who can use the resources extracted from it. But the notion that the paradigm case of ownership is real estate ownership remains so strong that even the 'bundle of rights' view continues to take ownership of resource stocks such as land as the default position, with the result that ownership of resource flows is conceptualised merely as a kind of fragmented stock ownership that can be bundled and unbundled. As Carol Rose put it, for modern legal scholars, "'property unmodified' still means land" (Rose

1998: 614).

But resource flows are not merely fragments of a resource stock, and ownership of those flows is not merely a bundle of fragments of absolute ownership. If resource stocks are analogous to capital, and resource flows analogous to flows of income, then the 'bundle of rights' view of ownership is analogous to the error of thinking that the sum of all flows of income from an investment is equal to the amount of capital invested. But the ownership of income flows is not the same as the ownership of the capital stock; the former is clearly not merely the latter fragmented. Yet this is exactly the error that the 'bundle' view makes.

This point is particularly important when analysing the ownership of energy resources. As noted above, legal scholars have tended not to think much about the right of owners to extinguish resources; yet things used for their energy, such as an apple, a fish, or a lump of coal, are destroyed by such use. It is precisely here that the distinction between stocks and flows is most useful: for the owner who has the right to destroy an item of resource flow in their possession need not necessarily have any ownership rights at all over the resource stock. Somebody may be permitted to catch and eat a fish but nevertheless be prohibited from landing the entire shoal, for doing so would destroy the entire resource stock. Clearly the distinction between stocks and flows is crucial to any analysis of the relationship between resource ownership and resource depletion.

3.4 Overuse tragedies

Indeed, neglect of the distinction between stocks and flows has been responsible for much of the confusion that surrounds theories of ownership and depletion, among the most infamous of which is the well-known 'tragedy of the commons' thesis. Advanced as a general argument by Garrett Hardin in 1968, the 'tragedy' thesis places private ownership in sharp distinction with common ownership, asserting that common ownership results in the overuse of resources, and concluding that the only two ways to prevent overuse are either state ownership or private property rights (Hardin 1968). Despite the article's popularity, it has been widely criticised for lacking clarity over terminology and for being unable to account for the many successful commons found throughout the world. George Appell concisely summarises the harsher critics of Hardin's article by describing the thesis as "conceptually flawed and empirically wrong" (Appell 1993: 5), and Hardin himself later recognised that he had mistitled the phenomenon he had described (Hardin 1991).

However, the confusion is not due to a simple mix up in terminology: the real cause is neglect of the crucial difference between resource stocks and resource flows. In a commons, different users claim ownership rights to extract resource flows, and it may even be that nobody asserts any claim to own the resource stock at all. If both the stock were unowned and the rights to the flow were unregulated, then overuse seems a likely outcome. But in

most real commons the ownership of flows is in fact very highly regulated. In actual historical commons in England, Wales, and elsewhere, commons have long been described as a system of individual rights in which each commoner is permitted to use the commons in a certain way (Hoskins and Stamp 1963, Ostrom 1990, Cole and Ostrom 2010). Note, however, that this view is very similar to that of the 'bundle of rights' conception of ownership popular among legal theorists, and that it too rests upon an implicit assumption that ownership of resource stocks is the paradigm form of ownership, thereby implying that the only real difference between a commons and a privately owned resource is that in a commons there are a larger number of people with rights to some resource stock. As a result, commons scholars have long tended to think in terms that assume stock ownership to be the paradigm form of ownership, implicitly defining commons in terms of a community with control over a particular resource stock (Ostrom 1990, McKean 2000, for example). Only more recently have commons scholars begun to move away from this conception of the ownership rights of commoners as a kind of fragmented ownership of a resource stock, and towards a conception of the rights of individual commoners in terms of the actions that they are permitted to take (Ostrom 2005, 2011, McGinnis 2011). Though I have yet to see it expressed explicitly in these terms, I suggest that this recent move represents a shift away from conceptualising a commons as the ownership of a resource stock by a community, towards the conceptualisation of a commons as the ownership of rights to resource flows by individuals governed by collective

rules. In short, to finally resolve Hardin's conceptual confusion: what is required to prevent resource overuse is proper management of the ownership of flows; as far as preventing depletion is concerned, the ownership of the resource stock only matters at all to the extent that it affects the rights that individuals have to resource flows. In order to prevent depletion of the resource stock, the rules concerning the rights to flows must be instituted with a regard for their overall effects on the resource stock.

3.5 External costs

The conceptual division between flows and stocks and the recognition that ownership institutions could perhaps be devised with regard to their wider social effects is also central to my understanding of the work on external costs or 'externalities'. Externalities are said to occur when one person uses things that they own in such a way that it imposes a cost on another person without that person's prior consent, for example when a person uses their factory in such a way that it produces air pollution which dirties their neighbour's laundry. Prior to Coase's seminal paper 'On the problem of social cost' (Coase 1960), the prevailing model, due to Arthur Pigou (Pigou 1920; 2013), had been that externalities occur when "there is a divergence between private and social costs" (Dahlman 1979: 141). For Pigou, this divergence needed to be corrected by state intervention in the form of taxation, regula-

tion, or subsidy, with such interventions making the creator of the external costs, a polluter for example, pay for the damage that their pollution causes, thereby internalising that external cost. In response to Pigou, Coase noted that if both parties held clearly defined ownership rights and there were no transaction costs involved, then both parties could reach an agreement without the need for third party intervention. In the case of the air polluter who dirties their neighbour's sheets, the polluter may choose to pay for the extra washing powder required to wash the sheets, or the neighbour may choose to pay the polluter to stop producing whatever is causing the pollution from their factories. In such circumstances, Coase argues, the contract agreed by the parties would match whatever was most beneficial to them collectively, since each party would not be willing to pay more than they would gain from the exchange. As a result, the private costs would equal the social costs, since the costs for each of the parties would be the best outcome for both parties combined, so within that two person system the outcome would be socially optimal (see also Lueck and Miceli 2007: 229-231). Coase emphasises – though this emphasis is not always noted by his followers – that in reality there are costs to transactions, as it costs time and money to make contracts in this way (see also Coase 1959). So, for example, if there are a large number of people affected by air pollution then it may in reality be practically impossible for them to form a coherent consortium to contract with the polluter, and the costs for each of those people to organise the group may be much more than each individual would have to spend on simply buying more wash-

ing powder for themselves. In such a high transaction cost scenario, even if the additional costs imposed by the pollution are much higher than the benefits gained by the polluter, the pollution would continue and the end result would not be socially optimal. So Coase suggests that, in the presence of high transaction costs, government intervention might be more appropriate than contractual agreements. This view is widely endorsed even by theorists such as Robert Nozick, Milton Friedman, and George Stigler who are not generally known for advocating governmental intervention (see Lai 2002 for a nice review). And though such theorists typically view external costs as a justification for what Stigler calls "limitations on private ownership" (Stigler 1987: 120-121), it is arguably just as Coasian to think of such government action as a defence of the rights of individuals who are prevented from enforcing their rights themselves due to the high costs of transacting for them. In the final paragraph of his seminal paper, Coase writes:

> the failure to develop a theory adequate to handle the problem of harmful effects stems from a faulty concept of a factor of production. This is usually thought of as a physical entity which the business-man acquires and uses (an acre of land, a ton of fertiliser) instead of as a right to perform certain (physical) actions. We may speak of a person owning land and using it as a factor of production but what the land-owner in fact possesses is the right to carry out a circumscribed list of actions ... In devising and

> choosing between social arrangements we should have regard for the total effect. This, above all, is the change in approach which I am advocating (Coase 1960: 44).

So the approach that Coase advocated, more than half a century ago, is that solving external costs would involve "divising and choosing" between ownership institutions that he conceives as "social arrangements". He also identifies the underlying theoretical problem to be a "faulty concept of a factor of production" that frames our thinking in terms of "an acre of land, a ton of fertiliser", and he suggests that what individuals in fact possess should instead be conceived as "a right to perform certain (physical) acts". Yet the literature has remained dominated by the idea that the things we own should be thought of as resource stocks, rather than as the rights to use resource flows. Whatever the reason, the shift away from treating absolute individual ownership of land as the paradigm form of ownership has been as conceptually difficult for institutional economists as it has been for commons scholars and legal theorists, despite the fact that a leading figure in their field long ago suggested that this is precisely what is required if we are to develop adequate theory.

It is worth emphasising again Coase's startling but underappreciated insight that the theoretical failure to solve the problem of social costs "stems from a faulty concept of a factor of production". Again: what is owned, Coase suggests, is not the physical entities such as land, but the right to perform

actions involving those things. Instead of continuing to try to theorise solely in terms of the ownership of resource stocks, the development of adequate theory requires us now to think of ownership, not only in term of real estate, but in terms of the right to use resource flows.

My approach to understanding ownership institutions, then, is the result of identifying the cause of previous confusions to be errors resulting from a neglect of the distinction between the ownership of stocks and of flows. Moving the focus away from the question of who owns the real estate permits a more nuanced and differentiated picture of ownership institutions, a picture in which the important differences between institutions, and the reasons for those differences, can be more readily identified and understood.

3.6 Property economics

The property economists Gunnar Heinsohn and Otto Steiger also argue that the work of new institutionalists, particularly Howard Demsetz, Douglass North, and Robert Thomas, has rested too heavily on an assumed dichotomy between individual and collective ownership (for example Steiger 2006). The basis of Heinsohn and Steiger's critique is that there is an essential difference between the mere possession of resources which can at most entail the right to physically use those resources, and titled property which allows the holder of property titles to use them as collateral for credit. Drawing on

Polanyi (1944), Heinsohn and Steiger suggest a useful idealised taxonomy for three ownership systems that have been instituted by humans in different societies[3] (Steiger 2006, Heinsohn and Steiger 2008, 2013). Roughly, these are the communal ownership institutions adopted by tribal groups that are maintained by an attitude of reciprocity, the command institutions such as the feudal seigniority that are maintained by the threat of coercion, and the titled property institutions that are maintained by money, contract, and the payment of interest.

I will shortly end this chapter with a proposal for a taxonomy of 'ideal type' ownership institutions that govern resource flows. This taxonomy is based on Heinsohn and Steiger's taxonomy but with two important modifications. The first modification I propose is the addition of 'possession' as a separate ownership category in the conceptual scheme. I propose to use the term 'possession' to describe the kinds of behaviours, hypothesised in animals and

[3]On a relatively minor terminological point: following a commentary by Niemitz (Niemitz 2008), Heinsohn and Steiger decided to use the word 'society' to refer exclusively to groups that have titled property institutions, and to use the word 'community' to refer to all others (see, for example, Steiger 2006: 203n4). Indeed, the German term *Gemeinschaft* is sometimes still associated with the Weberian ideal of a community in which interactions involve some affective element, and the term *Gesellschaft* with a society in which interactions are governed by impersonal law and ethics, a word which in everyday German can also mean 'company' or 'firm'. (Niemetz also distinguishes both of these from *Herrschaft*, though Heinsohn and Steiger do not place much emphasis on the distinction between the two). However, the English language does not distinguish between the words 'community' and 'society' in quite this way, and in any case even among German speaking sociologists the supposed distinction between *Gemeinschaft* and *Gesellschaft* has become largely deprecated since many different kinds of society involve both impersonal and affective interactions, and since the implication that premodern societies have neither law nor ethics is highly dubious. Almost all scholars these days tend to use the word 'society' simply to refer to a group of humans living together; this is the usage that I also adopt.

young children (J. M. Smith and Parker 1976; J. M. Smith and Szathmáry 1997; Kokko, López-Sepulcre, et al. 2006; Alcock 2005; Krier 2009; Stake 2004; Gintis 2009, Kummer and Cords 1991, Hook 1993, Friedman 2008, Brosnan 2011), where the initial possessor of an object retains possession of that object [4]. This proposal is contrary to Heinsohn and Steiger's use of the word to refer to communal and command ownership institutions, a usage that diverges considerably from the more usual use of the word both among nonexperts and academics, who use the word 'possession' to refer to the physical control of resources (Bromley 1989, 1991, 1992, van Griethuysen 2012). Indeed, Heinsohn and Steiger's usage actually completely obscures the fact that the key characteristic of communal and command ownership is that the initial possessor of an item does *not* maintain possession of it, but actually transfers the resource to others. For example, a hunter-gatherer under communal ownership actually actively transfers food in their possession to others in the group, whilst a serf or slave under command ownership actually surrenders what they possess to their master. Having tested various different formulations with diverse audiences of anthropologists, economists, historians, legal scholars, nonacademics, political scientists, and sociologists, including several already familiar with Heinsohn and Steiger's usage, I have found by far the most clearly understood terminology to be as follows: to use 'ownership' to refer to the most general category encompassing all kinds

[4]For clarity, possession differs from a situation in which ownership is absent, since if there were no ownership at all then individuals would simply take the possessions of others.

of practices and institutions that involve the control of resources; to use 'possession' to refer only to situations in which the first possessor actually maintains possession; and to use 'titled property' in the way that Heinsohn and Steiger use the word 'property', to refer only to a contract-based system of property right entitlements.[5] Again, all these categories are to be conceived as ideal types, and not thought to completely describe every transfer that actually occurs in any single society.

My second proposed modification helps resolve a problem with Heinsohn and Steiger's theory of interest, a theory that is the underlying motivation for their analysis of titled property institutions. Heinsohn and Steiger argue that interest is payment neither for the temporary loss of goods as suggested by neoclassical economics, nor the temporary loss of money as suggested by Keynesian economics, but for the loss of the immaterial yield which they call the 'property premium' (Steiger 2006: 184-185). Unlike other forms of ownership, they argue, resources governed by titled property may be sold and leased, and burdened and encumbered as collateral to secure loans. In particular, "[b]y burdening property for issuing money-notes ... in a credit

[5]Though overseen by Heinsohn, Frank Decker's translation of *Eigentum, Zins, and Geld* frequently uses the word 'ownership' where other publications by Heinsohn and Steiger in English use the word 'property'; indeed, the title itself is rendered as *Ownership Economics* rather than the more usual 'property economics'. Though it is true that the German word *Eigentum* translates either as 'ownership' or as 'property', it is not at all clear why Decker has not followed the convention established by Heinsohn and Steiger's other publications in English. Moreover, his ideosyncratic translation is itself somewhat inconsistent, perhaps most obviously where 'property assets' and 'property rights' are discussed alongside 'private ownership', this last his rendering of *Privateigentum*, a term much more usually translated as 'private property'. For clarity: the usage I propose here more closely follows the convention established by Heinsohn and Steiger's other publications in English.

contract, both lender and borrower give up their respective property premium, that is, they temporarily lose the freedom to burden, encumber, or sell it" (Steiger 2006: 186). It is this property premium, they argue, that an owner forgoes and that is compensated by interest, with the lender receiving interest because they cannot use the capital they have lent to secure debts of their own. But several critics of Heinsohn and Steiger have pointed out that loans need not be secured on collateral at all (Lau and Smithin 2002: 9, Strunz et al. 2015: 13). Though Heinsohn and Steiger acknowledge the existence of unsecured loans, particularly as the cause of financial crises (Heinsohn and Steiger 2008: 217), the closest they come to explaining their existence is to suggest that in such cases the debtor's collateral is merely not specified since the "quality of assets belonging to him or her is beyond doubt" (Heinsohn and Steiger 2000: 83). This claim is, however, empirically false. Among the many examples of loans where there is no collateral of any kind include banks and other money lenders making completely unsecured loans (Lau and Smithin 2002: 9) and loans that exceed the value of the collateral, as well as the extremely common practice of investing capital in businesses that hold negligible assets (Strunz et al. 2015: 13).

It should come as no surprise that the underlying problem with Heinsohn and Steiger's account is that it takes ownership of stocks as the paradigm form of ownership, and so is unable to provide an account of contracts that are titles to items of resource flow. Fundamentally, the right to future income flows

is precisely the title that is acquired by a creditor in a loan agreement, and what matters to the creditor is that they receive the flow of income for which they have contracted. Though some lenders may sometimes want collateral to insure against default, this is far from universal. Thinking solely in terms of resource stocks cannot account for the many loans that are made where the lender simply considers the debtor likely to repay the loan at interest. In short: we need to start thinking more in terms of the institutions governing the ownership of resource flows.

3.7 Working definitions of possession, communal, command, and titled property ownership

Following these two modifications, I propose the following taxonomy of 'ideal type' ownership institutions governing resource flows.

Possession is where an item is not taken if it is already possessed by another. For example, if one individual is the first to obtain an item, such as by picking a piece of fruit, then that item is not transferred from them to another.

Communal ownership is where initial possessors transfer what they possess to other members of the group; that is, it is community membership, not initial possession, that entitles an individual to those items, even if those

items are initially in the possession of another. For example, if an agent obtains a resource, such as by killing a wild animal, then that resource is transferred to others according to the particular rules of the group.

Command ownership is where initial possessors transfer what they possess to an agent of higher status; that is, it is status, rather than group membership or initial possession, that entitles an individual to those items. For example, if an individual with the status of serf or slave harvests some crop, then they surrender at least some of those items to another individual with the status of being their lord or master, with those transfers enforced by the threat of direct physical coercion.

Titled property is where initial possessors transfer what they possess to those with a legal title to those items; that is, it is contract, rather than status, group membership, or initial possession that entitles the individual to those items. For example, a farmer who has contracted for their crops, or a pickman who has contracted to mine coal, surrenders those items to whomever holds the title to those goods, according to the terms of the contract made between them.

I propose these 'ideal type' definitions of institutions governing the ownership of resource flows as a complement to the taxonomy of 'ideal type' private, public, common, and club resources established by the theory of public goods, which define the institutions that govern fund-services and resource stocks. And just as with that theory, a very promising avenue for

future research may lie in uncovering the characteristics of the resources that possession, communal, command, and titled property ownership institutions have evolved to govern; the next chapter of this thesis is one way in which such research might now proceed.

Conclusion

My main aim in this chapter has been to clarify the meaning of the terms we use to discuss ownership institutions. As the economist Daniel Bromley writes, "[c]oherent research on the role of institutions in economic history will be impossible in the absence of conceptual clarity concerning the precise meaning of institutions and their role in economic change" (Bromley 1989, quoted in Kopsidis and Bromley 2016: 186). Breaking the habit of thinking of ownership solely in terms of resource stock may be difficult, but it is crucial for achieving anything even approaching conceptual clarity. A whole series of debates, not least about whether ownership is a 'bundle', what causes resource depletion, and how to internalise external costs, are all fundamentally down to confusion over whether we are talking about the ownership of a resource stock or of resource flows. Drawing this distinction, a distinction every bit as fundamental as that between capital and income, helps us to clarify a number of important problems and, hopefully, to find better solutions to them.

Chapter 4

Literature review 2: changes in ownership

Introduction

In this second literature review, I critically survey the literature that attends to changes in ownership institutions as they relate to wider economic, social, political and technological transformations. Having differentiated different forms of ownership in the previous chapter, I here proceed roughly chronologically in terms of the ownership transitions discussed. The interrelationship between energy systems and wider socio-economic, political and technological arrangements is inevitably complex, and across literatures there has emerged a consistent tendency to distrust unicausal models (for example

Gurven, Hill, et al. 2004; M. N. Cohen 2009). One purpose of this chapter, therefore, is to create the intellectual space for a more unified approach to the energy-ownership relation that gives due consideration for all the many social, technical, political, and mental dimensions that may be relevant. This chapter then creates the intellectual space for a more explicitly evolutionary approach to the understanding the evolution of ownership as advocated by scholars such as Lee Alston and Bernando Mueller, who argue that the study of transformations in ownership institutions must take place in the context of understanding how they fit into changes in the wider ecological and societal landscape. They write:

> One of the main purposes of the literature on property rights is to understand the process through which they arise and change over time. Because property rights change, it has been natural to call the process the'evolution of property rights'. Yet in most cases scholars use the term "evolutionary" loosely to refer to gradual change over time and not to a well-defined process consisting of variation, selection, and heritability as in the Darwinian model of evolution. Classic papers ... have "evolution of property rights" in the title, but are based on an explanation of changes in property rights that is not founded on evolutionary theory, but rather on Harold Demsetz's hugely influential 1967 paper, *Toward a Theory of Property Rights*. Rather than pos-

> tulating a mechanism based on evolutionary theory, Demsetz's approach is grounded in neoclassical economics, with property rights changing whenever the marginal costs of altering the rights are exceeded by the marginal benefits of reducing externalities (Alston and Mueller 2014: 2256).

Harold Demsetz's paper is the point of departure for many of the discussions surrounding the creation of ownership institutions since its publication half a century ago. It is an exemplar of those who have taken a rational choice approach to understanding the way that secure rights in a resource – paradigmically land – may result from the rational decisions by individuals to bear the costs of transacting with one another and the costs of excluding outsiders once the benefits of doing so are sufficiently large. The argument in itself has oft been noted to be similar to much earlier views, dating back to as long ago as seventeenth century thinkers such as Thomas Hobbes and John Locke, who argued that when individuals appropriate from the environment they must also be prepared to fight others who might try to take what they have appropriated from them, though these conflicts might be reduced by some form of mutually beneficial agreement to foreswear attempts to take from others; Hume similarly saw ownership as the means by which people could be protected from the violence of others (Krier 2009: 148-151). As will be discussed in more detail in the next chapter, however, the Demsetzian approach says little about the precise mechanisms by which the relative

costs and benefits are calculated, and less about the precise forms that ownership might take, observing only that whether a society adopts inidivuals ownership or state ownership may partly depend on a "community's taste" for collectivism (Demsetz 1967: 350; see also Krier 2009: 142).

The literature review here takes seriously the distinctions between different forms of ownership, and proposes that if these forms of ownership are indeed to be explained in terms of the different 'tastes' of different communities, then those 'tastes' themselves remain in need of explanation. The review precedes by discussing in turn the various literatures that attend to changes in the ownership institutions, as defined in the previous chapter, as they relate to wider economic, social, political and technological transformations. The first section, then, attends to the changes surrounding the transitions communal ownership; the second to those surrounding transitions to command ownership; and the third to those surrounding the transitions to titled property institutions.

4.1 Review of the literature on the transition to communal ownership

A range of contrasting but largely complementary theories have been proposed to account for the transition to communal ownership among early

hominin hunter-gatherers. There is little disagreement that communal ownership emerged following hominin adaptation to new ecological niches, and that these adaptations included physical and cultural technologies such as exosomatic food processing using fire and tools, as well as physiological changes (Stahl et al. 1984; R. Wrangham 2009; R. Wrangham 2017). However, disagreements arise in two main areas. First, there is debate over the sequence and relative importance of different events, a debate yet to be settled – and which may never be settled – by existing archaeological evidence. Given the relative lack of conclusive archaelogical evidence, some theorists have turned to drawing inherently tentative inferences from extant social carnivores and hunter-gatherer groups, surrounding which arises a second debate regarding the mechanisms by which communal behaviours may have arisen among humanity's hunter-gatherer ancestors. This debate revolves around the relative importance of two broad mechanisms, known as 'tolerated scrounging' and 'reciprocity', by which widespread food sharing among non-kin may have emerged (Jaeggi and Gurven 2013a).

Beginning around seven million years ago, gradual climatic changes towards dryer and sunnier conditions led to changes in the ecosystem. Plants better adapted to the new savanna conditions thrived whilst those more suited to a forest environment declined (Edwards and S. A. Smith 2010). This included the decline in foods that were more easily edible by hominid foragers, particularly fleshy fruits and young leaves and shoots, which still form the

bulk of the diet of nonhuman primates (Stahl et al. 1984). Due to the decline in the habitats in which they had previously lived, from around four million years ago a series of extinctions known as the 'mammalian turnover pulses' took place over a period of up to two million years, in which many species of mammal including primates with more specialist ecological niches became extinct (Vrba 1993; Bobe 2004; Domínguez-Rodrigo 2014). As M. Rodrigo-Dominguez writes in a recent survey of the paleoecological evidence, there is now compelling support for the hypothesis that "human evolution ... was triggered by a change in the environment, involving increasing openness of the landscape and decreasing feeding resources" (Domínguez-Rodrigo 2014: 69).

Around 3.5 million years ago the first social carnivores emerged. These were species that gathered in groups and that adopted a more generalised diet, in particular obtaining a larger propertion of their diet from meat (Macho 2014). These social carnivores included the *Papio* lineage from which modern baboons have evolved and the last hominin, *Autralopithecus afarensis* (Macho 2014). Changes in diet led gradually to morphological changes in the genus *Homo*, and particularly from around 2.8 million years ago with the appearance of *Homo erectus*, large changes in the morphology of their jaws, digestive system, and body and brain size (Ferraro et al. 2013; Mann 2007).

Some controversy exists over the relative role that the control of fire played in

these morphological changes. Richard Wrangham's (R. W. Wrangham et al. 1999; R. Wrangham 2009; R. Wrangham 2017) 'cooking hypothesis' uncontroversially posits that "control of fire leads to such a large increase in energy acquisition and reduces the physical challenges of eating food so greatly that the evolution of an obligation to incorporate cooked food into the diet should be recognizable by evidence of novel digestive adaptations and increased energy use" but he more controversially suggests that "the only time in the fossil record when the appropriate changes are seen is the early Lower Paleolithic" (Wrangham 2017: 303). Wrangham originally proposed this theory in response to the prevalent theory that had recently been restated by Leslie Aiello and Peter Wheeler (Aiello and Wheeler 1995; Shipman 2009) who proposed that a meat-rich diet accessed with stone tools permitted digestive tracts to become smaller and allowed hominin brain size to increase even prior to human control of fire, an argument supported by the coincidence around 2 million years ago of the morphological changes they describe with the appearance of stone tool assemblages used for butchery. Subsequent discoveries have pushed back the earliest archaeological evidence that with some certainty dates butchery to around 2.6 million years ago (Ferraro et al. 2013; Domínguez-Rodrigo 2014), with lithic technologies associated with bone assemblages becoming more common in the period from 2.6 to 2 million years ago (Ferraro et al. 2013). Critics of Wrangham's 'cooking hypothesis' argue that there is an overwhelming lack of archaeological evidence to support the use of fire during the period he hypothesises for it to have occurred, and in

his recent review of the 'cooking hypothesis' controversy, Wrangham himself sets out the case both for and against his 'cooking hypothesis', including evidence for disease due to smoke inhalation, risk of predation among extant hunter-gatherers sleeping with and without fires, and consideration of wider morphological changes. Whilst conceding that "[a]rchaeological evidence of fire use is scarce before ca. 400 ka", he argues that it is not necessarily the case that "absence of evidence really is evidence of absence" since "the archaeological visibility of fire may vary too much to allow the history of its control to be confidently reconstructed" (Wrangham 2017: 303). Arguing that questions remain for both proponents and opponents of the cooking hypothesis, he concludes that "[a]t the present time no solution is satisfactory" (Wrangham 2017: 303) .

Irrespective of the relative importance of cooking in these morphological changes, there is little doubt that the exosomatic technologies of fire and tools eventually allowed hominins to more fully exploit their new ecological niches, driving the cultural evolution of societies that would come to include an increasing division of labour, increasing social interdependence, and the development of language (Fischer-Kowalski and Schaffartzik 2015: 4). The earliest evidence suggests that around two million years ago small bovids were hunted, with the remains at the same site suggesting that medium sized bovids were likely not hunted but their carcasses scavenged (Ferraro et al. 2013: 62174). Intriguingly, though this cannot of course be presumed

to be analogous to the behavioural evolution of hominins, chimpanzees in the savanna at Fongoli have recently been observed hunting small mammals with wooden hunting spears, making that population of chimpanzees unique both in living in the savanna and in using wooden hunting tools (Pruetz and Bertolani 2007). The very earliest archaeological evidence for the control of fire still dates to 790,000 years ago with claims of earlier evidence not widely accepted (Goren-Inbar et al. 2004; R. Wrangham 2017). Later, in some regions, fire may have been used to drive prey towards hunters or over cliffs, burning large amoungs of vegetation and killing more animals than can be eaten at the time of the kill, and perhaps contributing to localised extinction of large game (Fischer-Kowalski and Schaffartzik 2015: 4).

Fire is also thought to have affected social organisation as provisioning around a hearth may have led people to no longer consume food wherever they found it but to bring it back to central place (Fischer-Kowalski and Schaffartzik 2015 :4). The earliest currently known example of cummunal butchery have been found at Qesem cave in Israel, where bone assemblages dating between 400,000 and 200,000 years ago suggest a transition in communal sharing behaviours, as cut marks on bones from later during this period suggesting that carcasses were taken back to a central place, communally butchered, and shared (Gintis et al. 2015, Stiner, Barkai, et al. 2009, Riedl et al. 2012: 675). By around 250,000 years ago large game had become a prominent component of human subsistence (Stiner 2002), and around 200,000 years ago the earliest

evidence is found for the cutting of meat by a single butcher (Gintis et al. 2015; Stiner, Barkai, et al. 2009). This strongly suggests that procedures for butchering and sharing meat had become the responsibility of a single individual, as is the case in many present-day hunter-gatherers (Mameli 2013: 920). This behavioural shift is thought to mark a clear distinction between the behaviour of humans and that of other primates, for whilst a successful hunt among nonhuman primates concludes with a general scramble in which individuals in the vicinity compete to grab hold of some meat, these human hunters of large game appear to have peacably taken carcasses back to central places to be divided and shared among other members of the group (Hawkes 2001; Gintis et al. 2015; Tomasello, Melis, et al. 2012).

The mechanisms behind this cultural change towards active communal sharing are also subject to some debate. In the absence of archaeological evidence, some have turned to drawing inferences from extant social carnivores and human hunter-gatherers. In addition to using the term 'food sharing' to describe the active and voluntary transfer of food, they also describe a continuum of behaviours using terms such as 'tolerated scrounging' or 'tolerated theft' in which the taking of food by another is merely not resisted, and 'demand sharing' where the the transfer may still be described as "'the unresisted transfer of food from one individual to another" but only after the recipient has engaged in some degree of 'harassment' of the initial possessor of the resource (Jaeggi and Gurven 2013a). Others propose that communal

sharing may instead have evolved out of an anticipated 'reciprocity' as individuals became ever more prepared to share with others on the condition that they would similarly be shared with in the future. Discussions of the mechanisms by which communal ownership of food may have emerged among humans therefore focus on the degree to which transfers evolved as a result of 'tolerated scrounging' compared with the role that may have been played by the expecation of future 'reciprocity' (Jaeggi and Gurven 2013a).

The tolerated scrounging hypothesis rests on the notion that the same item of food may have a different use value to different individuals. This differential utility thesis is motivated on the basis that the same item of food might be worth more to someone who is starving than to the individual who originally acquired it. This is particularly hypothesised to be the case where large items of food that can neither be stored nor entirely consumed by a single individual have been acquired; once a hunter has eaten their fill, maintaining possession of the rest of the carcass is of little use to them. This differential utility suggests that once the first possessor has eaten all they can, there is little fitness benefit to them continuing to defend possession of the resource, especially if there is risk of injury in a fight (Winterhalder 1996, Jaeggi and Gurven 2013a). There is also the effect of the declining utility of the food as it spoils; this is, in effect, the converse of Harold Demsetz's hypothesis that it becomes worthwhile to assert ownership when a resource becomes valuable: as a resource becomes less valuable the closer it comes to spoilage the less

worthwhile it is to expend energy in its defense.

Fire continues to play a role in the 'tolerated scrounging' theory of communal ownership evolution, as central place provisioning has been hypothesised to increase instances of food sharing, since taking food back to central places creates more opportunities for scrounging (Marlowe 2005: 63). Even in the absence of more defined expectations of reciprocity, tolerating scrounging is thought to have some benefits beyond the mere avoidance of conflict with those scroungers. Inferences can be drawn from the behaviour of those canid, felid, and other primate social carnivores whose ancestors emerged to fill the ecological niches created by sunnier drier conditions 3.5 million years ago (J. E. Smith, Swanson, et al. 2012). Since most terrestrial mammalian carnivores are solitary, increased sociality is thought to have evolved as a derived trait where group life increases individual fitness through collective defence against predators and, particularly in species that hunt large game, through improved energy intake (J. E. Smith, Swanson, et al. 2012; Willems and van Schaik 2017). However, competition over food is typically sufficiently intense among nonhuman social carnivores to disrupt grouping behaviour, and most nonhuman social carnivores are therefore structured by fission-fusion dynamics in which groups break up in times of scarcity and reassemble when food is abundant (Aureli et al. 2008; J. E. Smith, Kolowski, et al. 2008). Though some species of nonhuman primate with difficult diets actively share with offspring, and in some of these species there is also sharing between

adults in mating or defensive coalitions, among nonhuman primates systematic sharing between non-kin is rare (Jaeggi and Gurven 2013b). Occasionally observed among nonhuman primates is an increased toleration for the scrounging or taking of food, particularly when the initial possessor has large fruits or large quantities of meat, though foods of such large package size do not typically constitute a large proportion of their diet (Gurven and Jaeggi 2015; Jaeggi and Gurven 2013b; Kaplan and Gurven 2005). These observations have led some to hypothesise that tolerance for other group members scrounging and taking food formed the basis for the speciation of humans who could cooperate; cognitive psychologist and evolutionary anthropologist Michael Tomasello even goes so far as to suggest that tolerance for food taking may have led to the speciation of humans from other primates, writing that "variation in tolerance around food among individuals of the last common ancestor to *Homo* and *Pan* might have served as the raw material on which natural selection worked on the way to a species that actively shared the spoils of collaboration" (Hare and Tomasello 2005, quoted in Tomasello et al. 2012: 676).

However, whilst tolerating scrounging might have provided the raw basis for active sharing, the mere toleration of scrounging is thought to be less clearly able to account for the sharing of food by extant human hunters who surrender what they have acquired to others for distribution; among extant hunter-gatherer groups food sharing is ubiquitous, and often successful

hunters neither claim ownership of what they have acquired nor control any aspect of its distribution (Winterhalder 2001; Hawkes 2001). For example, elaborate meat sharing institutions are found among the Netsilik Eskimo, in which twelve of the fourteen portions cut from a seal are distributed to a network of meat-sharing partners deliberately chosen during childhood to be outside the existing close relationships of the hunter (Flannery and Marcus 2012; Van de Velde 1956); similarly, among the !Kung of the Kalahari the distributor of the meat is chosen on the basis that their arrow was the first to hit the animal, but since arrows are regularly exchanged between hunters this is often not the hunter who took the shot, and may even be someone not present at the time (Winterhalder 2001; Hawkes 2001). Among the Ache of Paraguay it was long considered taboo for a hunter to eat portions of their kills (Gurven, Hill, et al. 2004), and meat distribution is still usually undertaken by an older man in the group (Hawkes 2001). Though the precise sharing norms and taboos against hunters taking possession of their kills may vary, the presence of such norms and taboos is ubiquitous amongst hunter-gatherers; in the words of Tomasello "there are no human groups who behave like other great apes in simply scrambling for food competitively in most situations" (Tomasello et al 2012: 675)

Reciprocity has therefore been proposed as an additional mechanism to account for sharing between unrelated group members. Though a variety of sometimes contradictory definitions appear in the literature, reciprocity is

typically theorised as transfers that are conditional on the recipient having previously shared with the current giver (Carter 2014: 5). Unlike tolerated scrounging, whereby an individual's fitness is directly enhanced through avoiding needless conflict, the mechanism of reciprocity relies on the adoption of behaviours that depend on the behaviours of others. In a seminal paper, Robert Trivers models the evolution of mutual reciprocity (what he called 'reciprocal altruism') in terms of a coordination problem in which an individual incurs a cost for helping another, but stands to gain a greater benefit in the long run if that help is later reciprocated, in which case both individuals benefit (Trivers 1971). In this way, communal ownership institutions are hypothesised to reduce variance in the food supply as, unlike foragers in temperate forests, hunters may go a long time without a kill: not only are large game animals less prevalent than smaller foraged foods, but an individual may also be prevented from hunting through injury or illness or may simply be unlucky for an extended period of time (Kaplan, Hill, et al. 1985, Gurven, Hill, et al. 2004, Cosmides and Tooby 2013: 214).

However, since reciprocity relies on responding to the behaviour of others, early models appeared to assume some form of cost-benefit analysis whereby an individual keeps score of their interactions with others in order to decide whether or not to share food with them. The long timescale of these interactions meant that reciprocity appeared to assume a high cognitive ability to keep track of previous food transfers in order for the mechanism to function

(Jaeggi and Gurven 2013a: 1). However, as Frank De Waal has pointed out, such 'calculated reciprocity' is neither hypothesised nor observed; instead, he argues, such behaviour is better thought of as a kind of 'attitudinal reciprocity' whereby individuals reciprocate with those with whom they have formed social bonds (De Waal 2000). Though De Waal interprets the term 'attitudinal reciprocity' to apply over fairly short periods of time, some have argued that the concept applies equally well, or perhaps even better, to long term reciprocal relationships (Schino and Aureli 2009: 59; also Tomasello and Vaish 2013: 234). It is thought that neuromodulators such as oxytocin, which plays an important role in mother-infant bonding, also play a role in non-kin social bonds, suggesting that animals have evolved instinctive emotional responses that help to create strong social bonds between reciprocating individuals over time. These emotions then provide a proximate mechanism by which reciprocal behaviours develop, without the need for complex cognitive abilities (Schino and Aureli 2009).

Among human hunter-gatherers, particularly those deriving the vast majority of their food intake from hunting, it is hypothesised that the selective pressure to remain part of a reciprocal community is all the stronger (Mann 2007: 104). As a result, reciprocity is thought to have become reinforced by the inculcation of social norms that may be negatively enforced by shunning or criticism of individuals who do not share enough (Mameli 2013: 920) as well as positively encouraged by the praise of generous individuals (Flannery

and Marcus 2012). These institutions enforce an effective egalitarianism, with those who try to obtain or retain more than their share, even though they may frequently be the first possessors of those resources, are resented and punished. This differs from the behaviour of other primates: though chimpanzees may avoid other group members they "do not seem to resent or punish them actively for being a bad partner alone" (Tomasello and Vaish 2013: 236). As Boehm and Flannery and Marcus repeatedly emphasise, among human hunter-gatherers there is continual social pressure to share and not to hoard, to reciprocate gifts that build social bonds, and to exhibit the virtue of generosity (Boehm 1999, 2012, Flannery and Marcus 2012). Moreover, since hunting tools can also be used as weapons, their development may also have played a key role in the evolution of communal ownership institutions by making it dangerous for an individual to refuse to share their possessions. This case is put powerfully by James Woodburn: "the means to kill secretly anyone perceived as a threat to their own well-being ... acts directly as a powerful leveling mechanism. Inequalities of wealth, power and prestige ... can be dangerous for holders where means of effective protection are lacking" (Woodburn 1982: 436; see also Gintis et al. 2015 for a recent restatement).

4.2 Review of the literature on the transition to command ownership

Given the striking egalitarianism of hunter-gatherer institutions, a large literature has also attended to the circumstances of the earliest emergence of hierarchical social organisation in which, characteristic of command ownership institutions, resources are transferred to those of higher status. This transition in ownership institution has long been thought to have roughly coincided with the transition to more sedentary societies, particularly those who first began to develop agriculture, though again, the exact sequence of events has long been a subject of debate. Two broad sets of theories have been put forward, both set out and popularised in a seminal paper by North and Thomas in 1977. The first hypothesis is that the innovation of individual ownership incentivised the processes of cultivation, or as North and Thomas put it: "The key to our explanation [of the transition from foraging to farming] is that the development of exclusive property rights over the resource base provided a change in incentives sufficient to encourage the development of cultivation and domestication" (North and Thomas 1977: 230). The second hypothesis, also stated by North and Thomas in the same paper, is that as humans adopted more sedentary settlement patterns, some individuals tried to exclude others from acquiring resources; in their words "individual bands began to attempt to exclude outsiders from access to the

resource base. In the process such bands became sedentary" (North and Thomas 1977: 240). It is hypothesised that the result of this process is that increased sedentism allowed particular groups to extract resources from those they have excluded, and to accumulate resource wealth and positions of status in ways that had been impossible among mobile hunter-gatherer groups (Fischer-Kowalski and Schaffartzik 2015: 4, Flannery and Marcus 2012). Here, I suggest that whilst recent research has cast doubt on the first of these hypotheses, the second hypothesis – that sedentism enabled a shift away from communal institutions and towards the command ownership characteristic of hierarchies whose elites could extract surpluses from others – has received increasing empirical support.

Beginning around 15,000 years ago, the archaeological record shows the start of what has become known as the quaternary extinction, a period in which many species of larger animals died out (Brook and Barnosky 2012). The ethnographic work of Lewis Binford (Binford 1968) suggests that extant hunter-gatherers do not become farmers unless there is no other choice (see also Price and Bar-Yosef 2011), and the archaeological evidence now strongly supports the view that the first farmers were not 'pulled' into farming due to its attractiveness but 'pushed' into adopting new food sources by the depletion of previous resources (D. J. Cohen 2011: 707, Price and Bar-Yosef 2011: 166). Particularly vividly, in Western Asia in the period from about 13,000 to 11,500 years ago, human groups significantly increased their consumption

of low ranked foods including bone grease, smaller faster game, and juvenile animals (Speth 2013), indicating that poorer diets had resulted from the depletion of larger animals (N. Munro et al. 2004, Stiner, N. D. Munro, et al. 2000).

During periods of scarcity, several extant hunter-gatherer groups who practice no cultivation whatsoever define areas within which individuals are permitted to forage for the low value resources they contain, resources that hunter-gatherers typically do not share beyond immediate family (Bettinger et al. 2007; Bailey 1992). This shift in behaviour is well documented amongst the tribes of the American northeast (Bailey 1992) and, similarly, the !Kung seasonally switch from a pattern of communal living in the summer where game is large and plentiful to a system of separate plots in the winter when game is small and when noncultivated plants provide a more important contribution to the diet (Kohler 1993). Periods of abundance occurred even less frequently for the Shoshone of Nevada, with tribes fissioning into separate multi-family camps and often remaining isolated for years at a time (Bailey 1992; P. Richerson and Boyd 2001). Though never conclusive, such examples may illustrate the way in which in some places the quaternary extinctions may to have led to groups fissioning into relatively isolated and more sedentary camps.

In western Asia, during the period 13,000 to 10,000 years ago, in those places where humans became more sedentary, several species of plants underwent

considerable changes. Several species of grain, in particular, changed as a result of the new selection pressures brought about by more sedentary humans. Previously, plants with smaller seeds that shattered early would be more likely to survive into the next generation. Human harvesters, however, preferred to collect larger seeds that shattered later, and in the process would accidentally propogate those seeds. Gradually, over a period of at least 500 years and usually over millenia, domesticated varieties with much larger and later shattering seeds coevolved with the emergence of more sedentary human groups (Purugganan and Fuller 2009; Fuller, Kingwell-Banham, et al. 2015; Larson et al. 2014; Price and Bar-Yosef 2011).

The once popular theory that domestication was delayed until the creation of an institution of individual land ownership is no longer so strongly supported, a point acknowledged by some of its previous proponents (Bettinger et al. 2007). In a recent restatement of North and Thomas's classic hypothesis, Samuel Bowles and Jung-Kyoo Choi state this thesis to be that the transition to agriculture "occurred because possession of the wealth of farmers' crops, dwellings, and animals could be unambiguously demarcated and defended" (Bowles and Choi 2013: 8830). Though ethnographic examples have sometimes been drawn upon to suggest that a lack of the appropriate ownership institutions may have been an impediment to the transition to agriculture, these examples are of mobile hunter-gatherers such the Hadza of Tanzania, the Batek of Malaysia, the !Kung, and the Hiwi of Venezuela,

groups that normally obtain a large proportion of their diet from hunting and who actively maintain communal ownership institutions (Bettinger et al. 2007, Bowles and Choi 2013). Indeed, recent ethnographic studies suggest that the institutions of extant low level horticulturalists far more closely resemble the more egalitarian practices of hunter-gatherers than they do the institutions of agriculturalists or pastoralists (E. A. Smith et al. 2010), and even among agriculturalists cases can be found in which communal ownership persisted in societies with a high dependence on domesticates, such as the Natchez of the American southwest who managed the entire crop as a communal effort and shared the produce (Bailey 1992). Again, though these cases are not necessarily analogues for the transitions that took place during the Holocence, these examples nevertheless suggest that the advent of individualised land ownership may not have been the prerequisite for domestication that was once thought.

Much more strongly supported is the hypothesis that sedentism was accompanied by social stratification. In western Asia, from around 12,800 years ago, clusters of small huts each probably housing a nuclear family appear in the archaeological record (Byrd 2002). This non-agricultural but largely sedentary Natufian culture already shows signs of some social stratification in the form of differences in grave goods and housing, though both sedentism and stratification disappeared during the more variable climatic conditions of the Younger Dryas from around 12,900 to 11,600 years ago (Boix and Rosen-

bluth 2014; Kuijt and Prentiss 2009; Price and Bar-Yosef 2010). With the return of a more stable climate, sedentary settlements returned to western Asia (P. J. Richerson, Boyd, and Bettinger 2001). Around 10,000 years ago, the early occupants of Abu Hureya in Syria lived in sedentary clusters of five to seven small houses, gathering wild rye, wild barley, two kinds of wild wheat and hunting, mostly gazelles; two thousand years later, occupants of the same site harvested domesticated wheat and barley and herded domesticated sheep and goats (Moore et al. 2000). In China, as in western Asia, sedentary settlements emerge several millenia before domesticated foods begin to make a significant contribution to subsistence (D. J. Cohen 2011). Research into the commonalities and differences between different agricultural transitions is ongoing (Larson et al. 2014; Ullah et al. 2015; Fuller, Kingwell-Banham, et al. 2015); it currently appears that whilst in western Asia, China, Japan, and northwestern Peru permanent settlements preceded cultivation, in India, Africa, and north America such settlements might have only emerged after the process of domestication was already well under way (Fuller, Denham, et al. 2014). Whatever the sequence, across sites paleobotanic research indicates that the rate at which wild plants were domesticated is comparable to the rate at which variation in wild varieties occur, suggesting that thousands of years of selection pressure by at least seasonally or semi-sedentary humans took place during the period in which domesticated varieties evolved (Fuller, Denham, et al. 2014; Purugganan and Fuller 2011; Fuller, Kingwell-Banham, et al. 2015).

In present day and historically studied societies, exclusion from resources seems to have typically occurred where sedentism allowed wealth, power, and status to be accumulated not only by individuals, but by lineages (Flannery and Marcus 2012; Ames 2007). Archaeological analysis of skeletal remains suggests that height differences within populations indicate greater levels of inequality in sedentary groups, and that this inequality increased during the transition to agriculture (Boix and Rosenbluth 2014). Among a cross-section of extant societies, greater inequality is found to accompany domestication where resources are limited, predictable, and monopolisable (Gurven, Borgerhoff Mulder, et al. 2010), and even in non-agricultural societies, sedentism has historically coincided with the hereditary accumulation of power, such as in the salmon-rich American Pacific north-west where powerful hereditary chiefs commanded tributes and held slaves who were sometimes cremated along with the chief's remains (Kelly 1995, Flannery and Marcus 2012). Flannery and Marcus (2012) offer numerous ethnographic examples to support their hypothesis that elites in sedentary societies continue to maintain prestige in sharing established among hunter-gatherers, but no longer shame those who hoard surpluses. As a result of this shift in 'social logic', they argue, prestigious individuals are able to amass wealth, which they can then distribute to others, with this apparently benevolent distribution further demonstrating their generosity and increasing their prestige. This subtle shift is enough to allow some dominant individuals to amass wealth by making gifts to the less wealthy, whose attempts to avoid humiliation by reciprocating such 'generos-

ity' results in their impoverishment and even enslavement.

The division between those who had monopolised resources and those excluded is hypothesised to have laid the foundations from which command ownership institutions arose, as those excluded from resources faced a choice between paying some form of tribute to those monopolists or suffering repulsion back into the less fertile areas from which they came. This is thought to have formed the basis for entrenched social division (Dow and Reed 2013). Theories of the evolution of institutional inequality include narratives of both the beneficial and the coercive aspects of hierarchical societies (Currie et al. 2016). The benefits of some level of stratification might include the creation of role models, the provision of dispute resolution, a division of labour, and the collective punishment of free-riders (Bowles 2009; J. Henrich and Boyd 2008; P. J. Richerson and Boyd 1998; Bowles 2009; Bowles 2012; Diamond 1997; J. Henrich and Gil-White 2001), benefits that do not differ greatly from those of belonging to a hunter-gatherer society, a similarity that perhaps helps explain why the relatively egalitarian institutions of low level horticulturalists tend to resemble those of hunter-gatherers (E. A. Smith et al. 2010).

However, the slow but steady advance of technology allowed intensifying land use, feeding larger populations on smaller areas (Fischer-Kowalski and Schaffartzik 2015: 5). The conversion of forests, wetlands, and drylands, and new technologies such as fireproof containers and the use of animals for traction

and transport, all increase the number and density of the population that agrarian societies can support (Fischer-Kowalski and Schaffartzik 2015: 5). It is thought that once a division of labour creates sufficient surpluses, then even without coercion such a social division may be enough for individuals to accept a low status in a stratified society over a precarious existence in a more egalitarian one (J. Henrich and Boyd 2008). High fertility, made possible in sedentary societies where mothers can take care of a large number of children at the same time, is thought to provide both a work force for increasingly labour intensive activities and added security (Fischer-Kowalski and Schaffartzik 2015: 5). Communities that aggregate more surpluses are also able to dedicate more resources to both defensive and offensive conflict (Skaperdas 1992), and allow some individuals to specialise in acquiring and exercising military skills as well as to develop larger infrastructure projects such as irrigation and eventually writing and administrative government, further increasing the surpluses the community are able to acquire – and defend (Fischer-Kowalski and Schaffartzik 2015; J. Henrich and Boyd 2008, Gowdy and Krall 2016). In western Asia and elsewhere, evidence of defensive structures, deadly raids, and the abandonment of farmland in areas affected by conflict support the theory that, given the alternatives, there may have been significant defensive benefits to group membership for even the most subordinate member of society (Sherratt and Mesterton-Gibbons 2015, Larson et al. 2014).

Alongside these theories of the benefits of stratification, theorists have also pointed to the coercive element involved in rank and wealth becoming inherited across lineages, sometimes becoming a self-perpetuating process that increases the coercive power of some individuals to extract resources from others (Mulder et al. 2009; Dow and Reed 2013; Mattison et al. 2016). Such developments are often resisted by the populace, with societies often cycling between periods in which political power is hereditary and periods in which such leaders are overthrown (Kirch 2010; Flannery and Marcus 2012). But where hereditary elites do become established, they are often able to demand significant amounts of resources from their subordinates (Fischer-Kowalski and Schaffartzik 2015). Societies with stronger heirarchies are generally able to command greater resources and soldiers and thus outcompete those with fewer resources and smaller armies (P. J. Richerson and Boyd 1998; Bowles 2009; J. Henrich, Ensminger, et al. 2010). Sometimes one chiefdom would achieve decisive victory over its neighbours, forcing unification; by the same process unified kingdoms were sometimes able to subordinate neighbouring kingdoms to create the first empires (Flannery and Marcus 2012; P. J. Richerson and Boyd 1998; Turchin et al. 2013). This pattern, first observed in western Asia, is later repeated in societies across Eurasia, Africa, and the Americas, with sedentism accompanying indicators of increasing hereditary inequality such as the burial of children with grave goods, the building of temples with priveleged spritual access to elites, and the gifting of elaborate decorative goods between elite families (Ames 2007; Flannery and Marcus

2012). In Mesopotamia, shipments of goods were sealed with impressed clay, a precursor to the future development of writing; the burial of a youth with such a seal around 7000 years ago is taken as another indicator that social position had become hereditary (Flannery and Marcus 2012; Merpert and Munchaev 1993).

4.3 Review of the literature on the transition to titled property ownership

There are two broad approaches to the study of the emergence of titled property institutions and their situation within wider social, political, economic, and technological transformations. Much of the literature attending to the emergence of titled property institutions focussed on the economic incentives afforded by secure individual ownership in contrast to both collective ownership and the lack of security associated with command institutions (for example North and Thomas 1977, Bayly 2003, North, Wallis, et al. 2009, Acemoglu and J. A. Robinson 2012). More recently, a distinct variant of this literature has begun to place greater focus on the importance of an owner's ability to use their property as collateral to secure loans (Libecap 1993, Heinsohn and Steiger 2003; Heinsohn and Steiger 2013, De Soto 2000). Within this latter literature, the first emergence of titled property is hypothesised to have originated in ancient Mesopotamia, and is linked to the emergence of the

earliest known markets in land, commodity and labour; these same processes are hypothesised to have occurred during the reemergence of titled property institutions and factor markets in Europe, and particularly England, during the late middle ages.

The idea that security of ownership provides incentives for economic production and exchange is central to much of the literature on the transition to property institutions. As Paul H. Rubin puts it "The economic purpose of a system. . . of property rights is to provide incentives for economic agents to undertake productive activity. If there is a high probability that the fruits of one's investments will be taken by others, then there is little or no incentive in the first place" (P. H. Rubin 2008: 209). Douglass North's work with a variety of co-authors brings together various explanations of this type to bear on the emergence of private property rights in England at the end of the middle ages. Based on comparative historical studies of the institutional causes of economic growth and stagnation (North and Thomas 1973, North 1981), North argues that economically successful states were those that had developed secure property rights that provided incentives for investment. In later work, he suggests that the development of these property rights are a means to limit violence by providing the dominant elites with an interest in maintaining an impersonal legal system that defends their interests by turning them into rights, rather than relying on violent conflict to achieve their ends (North, Wallis, et al. 2009). Historian Christopher Bayly endorses

North's account, suggesting that "relatively stable legal institutions guaranteed that economic advances were rewarded ... The inheritance of Europe's seventeenth-century ideological wars meant that governments and elites had reached an unspoken agreement not to tamper with property rights overmuch ... In eastern European, Middle Eastern, Asian, and African societies, property does appear to have remained rather more vulnerable to state intervention" (Bayly 2003: 61). As North emphasises, however, the kind of security that motivates those elites is the security of elite entitlement to collect rents; but by upholding the legal institutions that grant them those rights they create the institutions that provide citizens with ever greater scope for impersonal relations and exchange (North, Wallis, et al. 2009: 190, 256-261).

The extension of more secure ownership and impersonal institutions of enforcement and exchange is hypothesised to have led to the extension of markets. Avner Grief and Joel Mokyr have recently summarised the argument thus: "Higher trust in the enforcement of contracts and the security of property rights will encourage trade and the operation of financial and labor markets that require an expectation that one's partners will not behave opportunistically" (Greif and Mokyr 2016: 4). Others have emphasised the way in which production for markets became less of an opportunity and more of a compulsion (Brenner and Isett 2002, Wood 2012, J.-F. Gerber 2014). Robert Brenner and Christopher Isset, for example, locate the source of this compul-

sion in the actions of the landowners in western Europe, arguing that though they "failed to reinstate serfdom, lords did succeed in asserting their absolute property rights to the greater part of the land ... commercial landlords, unable, as the feudal lords had been, to take their rents by extra-economic coercion, were obliged to depend on rents determined by supply and demand ... The emergent class of direct producers ... were correspondingly obliged to maintain themselves through taking up commercial leases on a competitive land market. Compelled therefore to produce competitively to survive economically, these tenant farmers had to adopt an approach to their economic production that diverged sharply from that of England's medieval peasantry" (Brenner and Isett 2002: 618). This competitive production, it is thought, incentivised the adoption of new agricultural techniques as well as incentives to colonise new territory and develop new technologies, including eventually those that would make increasing use of fossil fuels to supplement or replace tractions animals and human labour (Pomeranz 2009, Smil 2010).

Increases in impersonal exchange are also the focus of Fernand Braudel and Immanuel Wallerstein, authors upon whom North frequently draws. These authors point to the increasing importance of local markets, markets that expanded over the course of the long sixteenth century to create a "vast but weak" global economy that grew to stretch from Poland the Americas (Braudel 1961: 260; Wallerstein 1974). A growing and increasingly wealthy middle class gained in power relative to the aristocrats, and land use changes

particularly towards pasturage for the production of goods for market accompanied the empoverishment and dispossession of rural labourers and many smaller farmers across the world (Wood 2012, Bayly 2003). Within this literature, debate continues as to why secure ownership in earlier times and in other places do not appear to produce the same effects – particularly economic growth – as those highlighted for England in the early modern period (Heinsohn and Steiger 2008:265, McCloskey 2010). North and Barry Weingast themselves concede that "the fundamental strength of English property rights" could be dated from at least as early as the thirteenth century; since similar security of ownership can be found in times and places other than early modern England, the problem of the peculiarity of the changes that took place there and then still remains in need of further explanation (Hodgson 2017, McCloskey 2010: 289-297).

Also drawing on North's work, an influential broadly Weberian tradition has examined the ways in which the modern firm has taken different forms in different institutional settings (Chandler 1977, 1990, Hollingsworth 1991, Whitley 1999). In the terms defined in this thesis, these variations are all between firms that exist in societies with titled property; Whitley calls these 'market economies, explaining that "[p]articularly important in such economies, of course, are the ways in which private property rights confer authority over the acquisition, use, and disposal of resources and activities" (Whitley 1999: 34). Though this literature does not focus on the transition to or from titled

property institutions, or place any emphasis on the energetic factors that are the focus of this thesis, this tradition has been influential in theorising the divergence of different business structures in different institutional settings. Chandler (1977), an influential early contributor to this literature, stated that the purpose of his book was "to examine the changing processes of production in the United States and the ways in which they have been managed. To achieve this end it focuses on the business enterprise that carried out these processes" (1977: 1). Contrasting the large multi-unit managerial enterprises that had emerged in the USA with the smaller traditional enterprise still more prevalent in Britain, Chandler drew on North to argue that the larger firms were more productive and more profitable than smaller firms, and so had ultimately replaced them. Chandler (1990) later extended his analysis from two to three ideal types, contrasting the 'competitive managerial capitalism' of the USA whose competitive virtues he continued to extol with both the 'personal capitalism' of Britain dominated by family owned firms and the 'cooperative managerial capitalism' of Germany that combined some aspects of US managerialism with family control, intra-firm cooperation, and a greater degree of paternalism towards the workforce. Chandler's approach soon became critiqued for its universalism and for its neglect of historical and cultural context (Hollingsworth 1991, Whitley 1999). Research soon came to focus on the distinctive institutional contexts in which businesses were located and the effects that this may have had on the forms that businesses assumed (Whitley 1999: 11). Roger Hollingsworth, in particular, drew on empirical

examples from the Japanese, German, and American economies after the second World War to argue that the economic performance of firms could not be improved simply by transferring the principles of coordination and governance from one society to another since "[e]conomic performance is shaped by the entire social system of production in which firms are embedded and not simply by specific principles of particular management styles and work practices" (Hollingsworth 1997: 265-266). Still drawing on North, Richard Whitley's 'comparative business systems' approach similarly begins from the idea that institutional settings provide the 'rules of the game' which shape the strategies and structures of firms (Whitley 1999). Emblematic of these, Whitley's study of the emerging East Asian and East European economies of the 1990s placed organisation and management at the centre of his analysis of divergent businesses, whilst seeking to create a systematic framework for the differences he observed. Going considerably beyond Chandler's typology of three, Whitley's sociological models generated six ideal types of business system (1999: 42), five different ideal types of firms (1999: 75), and a wide diversity of links between these types and certain fundamental institutional context that included the financial systems, skill development and control, trust, and authority relations (1999: 84).

Returning to the issue of why secure ownership did not always produce the same effects such as economic growth seen in early modern England, an increasingly influential argument in the twenty-first century scholarship has

been to suggest that there is something particular about the use that is made of property titles to collateralise loans, a use that is distinct from the mere security of title. These arguments are advanced by Hernando de Soto (De Soto 2000) and, independently, by Otto Stieger and his coauthors Hans-Joachim Stadermann (Stadermann and Steiger 2001) and Gunnar Heinsohn (Heinsohn and Steiger 2000, Heinsohn and Steiger 2013). Gary Libecap summarises De Soto's argument thus: "Secure tenure, as represented by formal, enforceable title, will offer collateral for accessing capital markets for ... investments and facilitate land sales" (Libecap 1993: 154). Heinsohn and Steiger similarly emphasise the importance of tenure security in providing the ability to collateralise, arguing that the mere possession of resources at most entails the right to physically use those resources, whereas 'property' consists of the creation of legal titles which allow the holder of those titles to burden assets when creating credit and to encumber them as collateral for securing loans (Heinsohn and Steiger 2000, Heinsohn and Steiger 2008, Heinsohn and Steiger 2013). Crucially, interest payments, they argue, are compensation for the loss of a proprietor's ability to further burden and collateralise their titled property.[1]

To make this clear, their argument is worth an extended analysis. According to Heinsohn and Steiger, whenever a legal title to property is created, there is

[1]The distinction between property and other forms of ownership is also found in the 1890 work of Paul Lafargue, in which he defines 'capitalist property' as "anything that produces interest" in contrast with other forms of ownership in which the owner of an item "utilises it himself instead of using it to extract surplus value from others" (Lafargue 1890: 6 n1).

simultaneously created a 'property premium' which consists of "the potential to burden assets to create and loan money or to borrow it" (Heinsohn and Steiger 2008: 194). For example, say that the legal title to some area of land is created and that land becomes the property of a given proprietor. Along with the creation of that title is the lawful ability to burden the land as an asset. This means that the proprietor of the land can create money-notes, which Heinsohn and Steiger call 'notified titles' to the property (Heinsohn and Steiger 2008: 192). The proprietor can use this money to acquire things through trade and will only be required to exchange something of actual value later, because the holder of the money effectively holds a 'notified title' to a portion of the proprietor's land, acting as a kind of guarantee that the proprietor will eventually complete the exchange with something of real value. The proprietor can also lend the money. Heinsohn and Steiger state that "the debtor too must burden assets" as collateral which will remain untouched by the creditor as long as "the borrower fulfils their obligations" (Heinsohn and Steiger 2008: 193). According to Heinsohn and Steiger, the borrower pays interest to compensate the proprietor for the loss of their property premium, that is, the loss of the proprieter's "potential to burden assets to create and loan money". This, they argue, is the answer to "economic theory's key question: *what is the loss that must be compensated by interest?*" (Heinsohn and Steiger 2008: 184, emphasis in original).

Heinsohn strongly argues that commodity markets first arose in ancient

Mesopotamia from the settlements of debts between "private proprietors who have no choice but to constitute a market to turn their commodities into the means in which their debts are contracted" (Heinsohn 2008: 249, quoting his 1982 dissertation). Since his focus is on secured loans the settlement of debts by nonproprietors remains relatively neglected throughout his analysis; however, all the evidence suggests that credit was also contracted by non-proprietors in ancient Mesopotamia, with these contracts a defining feature of the way in which ancient rulers and, later, private creditors accumulated wealth by offering interest-bearing loans of seeds, animals, and materials to tenant farmers and extracting a fixed rate of return (Garfinkle 2004; M. Hudson 2000; M. Hudson 2002: 49). Defauting proprietors could lose their land, stimulating a market in land and the accumulation of land by increasingly wealthy creditors; similarly, evidence for the emergence of a labour market appears as early as the late third millennium BC, as wages likely became the only means by which propertyless individuals could pay off their debts (R. M. Adams 2006: 160, 164).

Heinsohn and Steiger also advance an important argument that the interest that accrues upon loans is a key driver of an increase in economic activity. They write that "The demand for a rate of interest forces upon [the debtor] a value of production, expressed in terms of quantity, time, money or price, which must be greater than the money proper advanced as capital. This demand thus necessitates a value surplus in the production of commodities,

the rate of *profit*" (Heinsohn and Steiger 2003: 511, emphasis in original). Debate continues about whether the positive interest rates that arise from property constitute a growth imperative, with much of this literature now following Hans Christoph Binswanger (2013) in explicitly distinguishing between an unavoidable systemic growth imperative, and a growth impetus or driver which merely incentivizes economic growth (Strunz et al. 2017). To the extent that interest-bearing loans incentivise debtors to return a greater value than they have borrowed, such loans are considered to drive growth and perhaps even constitute a growth imperative. The demands imposed upon debtors, which Rolf Steppacher and Pascal van Griethuysen identify and discuss in terms of solvency, profitability, and time pressure (Steppacher and van Griethuysen 2008, van Griethuysen 2012), combined with the pressures of avoiding dispossession and the processes of accumulation of the lands of the dispossessed are held to be important features of the current economic system, and are thought to have played a pivotal role in the societal transformation accompanying increasing markets in land, labour, and capital that occurred in England from the sixteenth century onwards (van Griethuysen 2012; J.-F. Gerber and Steppacher 2014, Wood 2012). The analytical distinction between secure ownership and titled property that may be used to secure debt provides a crucial insight that helps to relate the wider social transformations that occured in England to the dynamics of earlier societies that also adopted similar titled property forms (see Chapter 7 of this thesis).

Conclusion

In this second literature review, I have critically surveyed the literature relating the wider social, technological, and economic transformations to transitions in ownership institutions. Each of these transitions is clearly complex, and unicausal models have increasingly given way to more nuanced accounts of these transitions. Increasingly attention has been paid to the interrelationships between individual motivations, ecological constraints, technological innovations, and institutional changes. This has created the intellectual space for a more unified approach to ownership institutions in general. In the next chapter, I present a third literature review in which I critical survey the scholarship on institutional change more broadly, highlighting the recent development of an evolutionary institutionalism as a complement and extension to existing 'rational choice' and 'historical' theories of institutional change.

Chapter 5

Literature review 3: three institutionalisms and the 'building blocks' of an evolutionary approach

Introduction

Rational choice institutionalism and historical institutionalism have long been the two most prominent approaches in the study political instituitions (Fürstenberg 2016). More recently, a third approach, evolutionary insti-

tutionalism, has been developed by political scientists and related disciplines. In the previous chapter, I surveyed the literature of theories of ownership transformation in relation to wider social, economic, and technological changes, and in this third review place that literature into the context of wider theories of institutional change. Helped considerably by previous reviews (Fürstenberg 2016; Currie et al. 2016; Lewis and Steinmo 2012; Krier 2009; Gintis 2009), I outline the literature on the rational choice and the historical approach to the study of institutions. I then survey the arguments made by advocates of evolutionary institutionalism, who propose that useful analysis of political institutions may be made by applying a generalised Darwinist framework of variation, selection, and retention to those institutions. Using this framework, I identify the 'building blocks' from which I construct the evolutionary model in the next chapter.

5.1 Rational choice institutionalism

Rational choice institutionalism operates upon the hypothesis that a political institution is instituted as the result of actions by a population of rational actors (Fürstenberg 2016). These kinds of theory about the institution of ownership posit rational actors who assess the costs and benefits of excluding nonowners and contract between owners to agree upon a particular ownership institution to govern a particular resource. Criticisms of this approach

typically centre on the assumptions it makes about the actors, especially the assumption that they have complete information about all possible strategies and that they are strictly self-regarding in their strategy choice (Fürstenberg 2016; Shepsle 1989; Ostrom 1998; Gintis 2009). Also problematic is that strategies that are available to individuals in reality are excluded because they cannot be reproduced in the chosen model; this is the objection that Elinor Ostrom raises against rational choice models when she suggests that common ownership inevitably results in tragedies of resource overuse only if actually used strategies of common pool resource management are excluded from the 'tragedy of the commons' model (Ostrom 1998: 4).

A consequence of the assumption of complete information for rational choice institutionalism is that institutions are essentially static, since once the strategies and choice sequences are defined, the actors' information is completely specified and their best strategy is rendered calculable. So actors have no means to change strategies, and rational choice institutionalism cannot so easily explain variation between institutions or their change over time (Weyland 2002; P. W. Roberts and Greenwood 1997). This type of critique is levelled against the rational choice approach to the institution of individual ownership: the Demsetzian theory states that if the costs and benefits of doing so incentivise it then ownership will be instituted, but does not obviously explain the transition from individual ownership to other ownership forms, such as the communal, command, and titled property ownership described

in this thesis (see also Krier 2009).

5.2 Historical institutionalism

The historical institutionalist approach does not begin from the perspective of a population of rational agents but from case-specific institutions and actors (Steinmo 2009; P. A. Hall and Taylor 1996). In doing so, it takes political, cultural, and social restraints seriously, not only in the form of formal institutions such as legislation and constitutions, but also less formal norms and values (P. A. Hall and Taylor 1996; Steinmo et al. 1992). An example of this is the debates surrounding the varieties of business ownership that developed during the twentieth century, with early accounts relying on a broadly rational choice explanation in terms of efficiencies brought by lower costs to explain the replacement of smaller firms with larger multiunit enterprise in the US (Chandler 1977, 1990), an account later criticised for neglecting the historically contingent nature of economic coordination (Hollingsworth 1997, Whitley 1999). Two core ideas form the basis of historical institutionalism: that crucial changes can occur at critical junctures, following which there is an institutional path dependency during which the consequences of the changes that occurred during the critical juncture play out until the next critical juncture arises (Mahoney 2001). For example, upon the localised depletion of large game, a critical juncture arises in which

a hunter-gatherer community may become increasingly mobile in order to follow the remaining large migratory animals or may become increasingly sedentary around smaller but more reliable resources; this bifurcation may either lead to a path of high mobility and continued communal institutions or a path of increased fissioning into smaller family units.

Identifying critical junctures is not always straightforward, and remains a conceptual problem for historical institutionalism. James Mahoney defines a critical juncture as composed of two elements: a situation with multiple choices in which only one choice can be taken, and the increasing difficulty over time of changing the choice that was made (Mahoney 2001: 113). But as with rational choice institutionalism, the options that appear available to a researcher may not have seemed at all obvious or been realistically available to an individual at the time; the option to settle down and create domesticated agriculture may seem obvious in retrospect, but clearly seemed less obvious to those who had never experienced domesticated plants or animals before. The concept of path dependency is similarly sometimes criticised as problematic, since it appears to make instititutions unrealistically rigid and hard to change. This downplays the ability of individual agents to bring about institutional change, largely relying instead on exogenous shocks that create new critical junctures after which the consequences of the decisions made during those junctures become ever more difficult to control (Lewis and Steinmo 2012).

5.3 Evolutionary institutionalism

Evolutionary institutionalism draws on the generalised Darwinist framework applied to genetic evolution to propose that political institutions can be analysed in terms of variation, selection, and retention (sometimes called 'inheritance'). Currie et al. follow the standard definition of evolution used in biology, as 'descent with modification' to encapsulate the way in which variation, selection, and retention lead to changes over time (Currie et al 2016: 202). An analogy between institutional evolution and genetic evolution is often justified on the basis that both institutions and genes can be described in terms of rules that govern a particular form or function: a gene may encode the physical expression of hair colour, say, whilst a statute may legislate for the physical exclusion of certain individuals from particular resources (Lewis and Steinmo 2010). The analogy, though perhaps useful and intuitive, is just an analogy; Currie et al. (2016) emphasise that the purpose is not to draw analogies for the sake of it, but to use an evolutionary framework to better understand how certain traits will change over time in certain conditions. The analogy with genetic evolution, then, is not the basis upon which evolutionary institutionalism operates; what is fundamental is the generalised Darwinist theory of change as a result of variation, selection, and retention. As a result, there is not a single evolutionary hypothesis, but a general theory that provides a framework for generating more specific hypotheses about the way in which political institutions arise, spread, and change, hypotheses that

can then be used to guide empirical research (Currie et al. 2016: 205).

The core idea is that variations arise as some change in an institutional arrangement; that a processes of selection occurs in which some of those variations are selected and some are not; that those variations that are selected are retained, and a new round of variation then occurs. Institutional variation can occur as the result of the implementation of agents' ideas, as well as by the imperfect replication of previous institutional forms (Lewis and Steinmo 2012: 322). So, the idea of charging interest upon a loan may be thought up in one polity and instituted by the ruling elite there as a means to simplify their accounting processes; a neighbouring polity might permit such an institution only for commercial loans, a third for all individuals, a fourth may permit compounding of interest whereas a fifth might not, and so on. Variation need not be the result of deliberately implemented changes, however, and may be the result of imperfect replication. For example, the prohibition on charging interest to anyone other than a commercial traveller might later be misinterpreted as a prohibition applying only to certain ethnic groups, leading inadvertently to a new institutional variation (see Chapter 7 of this thesis). Smaller variations might also occur and accumulate, ultimately leading to larger institutional changes; for example, one individual might begin to feel that the moral imperative not to charge interest on commercial loans should not apply to loans upon which they risk some loss, an attitude that may be noted by that lenders business partners and neighbours who emulate

that individual, leading to a wider institutional changes. Evolutionary institutionalism thereby allows individuals to influence institutions continuously, in contast with historical institutionalism which posits the influence of even powerful individuals to be limited to the timeframe of those critical junctures (Fürstenberg 2016: 53). Moreover, if people begin to realise that a previously privately held belief is actually shared by a large enough proportion of the population, this could lead to rapid and discontinuous institutional change (Currie et al. 2016: 207). Individuals are where institutions are replicated, and both within generations and across generations individuals interpret institutions differently and so replicate them differently, leading to a variety in institutional forms (Lewis and Steinmo 2010; Lewis and Steinmo 2012). Under an evolutionary institutionalist approach, then, institutional variation may be unexpected and inadvertent as well as the result of individual agency.

Within evolutionary institutionalism, change is theorised to occur at different societal levels, and originate from a variety of sources. Orion Lewis and Sven Steinmo propose that institutional change rarely results solely from endogenous variations or exogenous influences, but usually relies on some variety of the two (Lewis and Steinmo 2010). The example of the localised depletion of large game is again an apt illustration of the way in which a change exogenous of the institutional arrangement might provoke a shock upon that arrangement; but the form of institutional variation that takes

place may in turn depend on factors endogenous to those institutions, such as the strength of the inculcation of sharing norms, which in turn may affect the likelihood that a group with the propensity to continue hunting continues to thrive.

In this way, agency and institutional structure are integrated and mutually interacting: institutions structure agency and agency shapes institutions. The actions of individuals, and the preferences that inform them, are conceived as complex and may change with time and circumstance; for example, in times of plenty one may find oneself entertaining a wildly altruistic and generous disposition, but find that such a disposition evaporates in times of scarcity or if others turn out to be much less generous than one is oneself. These different preferences are not mutually exclusive, nor is one intrinsically more rational than another: actions are influenced by multiple frames of reference and depend on the context in which they take place. In this way the preferred actions of individuals aggregate to shape institutional outcomes, whilst the preference of individuals are themselves defined within the institutional structure: individuals are socialised into institutional contexts through formal and informal education, socialisation by peers, and sometimes formal and informal punishment that all constrain the range of actions that actors consider possible (Currie et al. 2016: 209-210).

In an evolutionary account, then, endogenous and exogenous factors are integrated. Whilst rational choice models largely focus on individual eco-

nomic advantages and historical institutionalist accounts restrict agency to the short timeframe within which critical junctures takes place, evolutionary accounts are proposed to place a greater focus on the interactions between both existing institutional structures, the agency of individuals within those structures, and influences external to both. Since it operates at multiple levels, evolutionary institutional analysis can examine changes both in terms of micro-level changes in the day-to-day activities of individuals, macro-level changes of large-scale systemic change, and the role of external shocks such as war or climate events (Lewis and Steinmo 2012). Kai Fürstenberg provides the example of historical state formation as an example of the complex interactions between political, social, and natural factors such as the rise of the bourgoisie, competition with other powers, and harvest failures due to climatic changes. Noting that that until now evolutionary institutionalism has focussed on providing an approach wherein actors are able to shape institutions, Fürstenberg suggests that the role of environmental factors has been relatively underresearched by evolutionary institutionalists; he writes "An ecosystem-wide view helps make sense of evolutionary process, of agency, and of structure. To many researchers, especially those concerned with historical development, a contextual approach fully including natural events will feel familiar. What historically oriented researchers may still be missing, however, is a political-science approach systematizing context so as to situate an ecological niche within its ecosystem" (Fürstenberg 2016: 55).

Though theorists of institutional evolution have recognised the importance of ecological contexts, the precise role of ecosystems is not always made explicitly clear (Lewis and Steinmo 2010). Yet in many cases it may have central importance in an account of institutional change. Indeed, though institutional theories have often been placed in opposition to geographical and ecological theories (Diamond 1997; Acemoglu and J. A. Robinson 2012 serve as reviews), they need not be considered dichotomous in an evolutionary approach in which agents, institutional structures, and ecological constraints are integrated and interact. A recent example of such research is Turchin et al. (2013), where it was suggested that more cohesive societies are more likely to be selected where warfare is most intense, a hypothesis prompted by a model suggesting that the costs of maintaining cohesive institutions are outweighed by the military benefits of being cohesive during conflicts with others. They go on to hypothesise that the origin of more intense rivalry coincides with the presence of horse-based technologies of war such as the chariot, and that these rivalries tended to play out between settled agriculturalists and nomadic pastoralists in steppe regions, suggesting a sequence of interelationships to explain the presence of more cohesive societies in those steppe ecologies.

In calling for more attention to be paid to ecology in evolutionary institutional research, Fürstenberg writes: "Institutional evolution might sometimes be unexplainable within the small scope of variables exclusively taken from

political and socioeconomic contexts, but it becomes understandable when looking at climatic changes or geophysical crises. To accept that institutions are historically grown and subject to more than political or economic forces is crucial for truly understanding institutional development and evolution" (Fürstenberg 2016: 54). Fürstenberg cites the work of Jared Diamond as one well known example of the way in which the rise and declines of different institutional arrangements throughout history is thought to have been shaped by environmental factors, describing the circumstances in which the first kingdoms arose as dependent upon their proximity to rivers with yearly floods and defined harvesting seasons that made possible the creation of institutions to govern storage, taxation, and the employment of peasants outside of harvest times, and attributing the declining complexity of the Mayan institutions to the stress of drought (Fürstenberg 2016: 45-55). The hypothesis that a society's institutions vary, are selected, and are retained as a result of their interaction with the natural world – as well as the point that many existing theories neglect this – is likely one with which many of those reviewed in the first literature review of this thesis would find themselves in agreement.

5.4 The building blocks of an evolutionary model of ownership institutions

Institutions are complex and exist in a large variety of forms, yet the data that is available to study them is often fairly limited. The purpose of modelling institutions, then, is not to attempt to capture every possible factor in every possible relationship between agents, structures, and their ecology, but to try to better understand the dynamics of some small part of the complex system under study. No single method is inherently superior to any other, and a range of approaches provides the prospect that a wider variety of insights into the functioning of an institution may be revealed (see also Curriet et al. 2016). In this vein, rational choice institutionalism and historical institutionalism, alongside a vast array of statistical, comparative, and computational methods, may all play a role in examining the evolution of ownership institutions. In light of the discussion in the previous section that situates evolutionary institutionalism as a promising theoretical framework for exploring the interactions between agents, institutional structures, and their ecological circumstances, it is a methodology that seem particularly well placed for the task of shedding some small amount of light upon the energetic correlates of the ownership institutions that are the subject of this thesis.

In addition to the theoretical and conceptual appropriateness of an evolu-

tionary institionalist approach, there is a long precedent for the use of evolutionary game theoretic approaches to modelling possessive behaviours[1] by biologists (J. M. Smith and Parker 1976; J. M. Smith and Szathmáry 1997; Kokko, López-Sepulcre, et al. 2006, Alcock 2005: 264-273), and others who have similarly hypothesised that animals behave possessively and extended the logic of the biologist's argument to humans (Sugden 1986; Krier 2009; Stake 2004; Gintis 2009; Eswaran and Neary 2014; Sherratt and Mesterton-Gibbons 2015). In so doing, they draw inference from reports that members of many species of animals, including various spiders, insects, birds, and mammals, resolve disputes between conspecifics by observing a 'deference to possession' in which a new arrival defers to the individual that has previously acquired a resource (Krier 2009; Stake 2004; Gintis 2009; Kokko, López-Sepulcre, et al. 2006; Alcock 2005). This deference to possession is hypothesised to be a product of biological evolution, with its core explanation – and the use of evolutionary modelling to do so – credited to the biologist John Maynard Smith (J. M. Smith and Parker 1976; J. M. Smith 1979, see also Krier 2009: 152).

In simplified form, the logic of Maynard Smith's explanation is as follows. The situation is such that two members of the same population wish to have possession of some resource, whose value v is determined by the gain that this

[1]This thesis does not assume that either animals or humans behave possessively with regard to objects or territories, and any such behaviours as portayed as outcomes in the model in the next chapter are considered hypothetical 'ideal type' behaviour and is not assumed to represent actual behaviours. I thank my examiners for raising this point.

resource would represent for the likelihood with which they will survive and reproduce a next generation, that is, for their reproductive fitness. Either of the two individuals might arrive first to acquire the resource and be its initial possessor, and all will either adopt an aggressive strategy which Maynard Smith dubbed 'Hawk' or a passive strategy he called 'Dove'. Hawks fight until one or other is injured, and in any conflict between two Hawks either animal has an equal chance of winning; injury carries a cost c in terms of reduced reproductive fitness. Doves, however, do not fight and so avoid injury; as a result they lose resources to Hawks but also share any resources with other Doves. The relative costs of the two strategies are typically set out in a two-by-two table like this:

Table 5.1: Payoffs in the Hawk-Dove game

	H	D
H	$\frac{v-c}{2}$	v
D	0	$\frac{v}{2}$

Payoffs are to the row player (on the left).

In a population consisting of some mix of agents adopting each strategy, Maynard Smith examined whether Hawks or Doves would be the fitter strategy. The first part of that answer is that it depends on the ecological circumstances, as expressed in terms of the value of the resources relative to the costs of fighting over them. Mathematically, if the value of the resource is greater than the costs of injuries incurred through conflict ($v > c$), then Hawk is the fitter strategy because the likely losses are outweighed by the

likely fitness benefits: in other words, when $v - c > 0$, and hence $\frac{v-c}{2} > 0$, the risk of injury is worthwhile.

Moreover, Maynard Smith hypothesised that a hybrid convention may evolve, whereby the structural outcome of the game depends not only upon agent strategies and ecological variables, but also the structure of the interaction between agents within the population. This hybrid is neither a consistent Hawk nor a consistent Dove, but adopts a new rule: if they are the first possessor of a resource they play Hawk, but if they are a latecomer they play Dove. Maynard Smith dubbed such as strategy Bourgeois. With such a strategy, as long as the ecological constraint that $v > c$ is met, Bourgeois agents protecting what they possess whilst deferring to those already in possession fare better than either pure Hawk or pure Dove strategies since the hybrid avoids both the damaging encounters with Hawks whilst still receiving more shared resources than pure Doves. This strategy functions as a result of an observable asymmetry between the possessor and the new arrival, an asymmetry that is recognised by both; without this mutual recognition, Bourgeois players would not be able to identify whether they should play Hawk or Dove in any given interaction. Physical possession, then, is hypothesised to be among the simplest, unambigious, and unfalsifiable ways to signify the intention to play Hawk and to fight to maintain possession of a resource, but other signifiers might include physical markers such as fences (Krier and Serkin 2015: 5) or verbal signalling such as food calls (Gros-Louis

2004). It has been suggested that such markers of first possession extend the concept of simple first possession, and might be differentiated as 'constructive possession', since an individual signifies that they have both the ability and the intention to defend an object even though, temporarily, they may not actually be physically in contact with it (Krier and Serkin 2015: 5).

As in each successive generation more Bourgeois players survive to reproduce than pure Hawks or Doves, eventually the entire population adopts a Bourgeois strategy. Such a strategy is described as being one that is an "evolutionary stable strategy" since once it has taken hold it cannot be defeated by the introduction of new Hawks or Doves into the population. Moreover, such behaviours are hypothesised to increase evolutionary fitness of individuals not only at the level of individual selection, but also at the level of the group: the reduction in conflict means that serious or fatal injuries to other group members are less likely, and other members are less likely to leave the group merely to avoid conflict (Aktipis 2011). As a result, the group may increase in size (West et al. 2011, Kokko, Johnstone, et al. 2001, Schino and Aureli 2009: 46), and even without much direct interdependence between individuals, being part of a larger group is hypothesised to increase an individual's fitness, as larger groups are likely better able to defend against rivals and predators.

In this manner, evolutionary game theory has been used since its beginnings to produce simple models that elucidate the dynamic mechanisms by which

behavioural conventions akin to ownership institutions might arise as a result of the interactions between agents in given ecological circumstances. Thus, the building blocks to a more extended evolutionary model of the evolution of ownership of the type presented in the text chapter are present from evolutionary game theory's inception: these essential building blocks are the agents with a variety of possible stategies, the institutions that are structured as a result of the interactions between them, and the ecological conditions in which those institutions are able to survive.

Further applications of Maynard Smith's analysis have been made within the social sciences (Sugden 1986; Krier 2009; Stake 2004; Gintis 2009; Eswaran and Neary 2014; Sherratt and Mesterton-Gibbons 2015). Robert Sugden was among the first, suggesting that humans were like other animals in appearing to have an "innate sense of possession and territory" (Sugden 1986: 107), subtly altering the measure of fitness to become a wider measure of individual success, allowing strategies to be determined not only genetically but consciously by individuals, and then applying the same evolutionary procedure to show that a basic deference towards first possession could arise, as in the Hawk-Dove-Bourgeois model, in the absence of a central authority. Similar claims have repeatedly been made on the same basis (Sugden 1986; Krier 2009; Stake 2004; Gintis 2009; Eswaran and Neary 2014; Sherratt and Mesterton-Gibbons 2015). However, the game theory model of ownership as it currently stands focusses on the hypothesised evolution of possessive

behaviours in animals and humans, and so has yet to be extended to those institutions of ownership that govern the transfer of resources between individuals – those very institutions that, I have argued, are most characteristic of human societies (Chapter 3). Partly, this is because the model has largely been developed by biologists for the purpose of studying the hypothesised possessiveness of animals, but partly also because of the previous dominance in the literature of the rational choice influenced 'standard story' by which the evolution of ownership is reduced to the establishment of individual ownership of an ever greater number of things (Pagano 2016; see also Chapter 1 of this thesis). This is, in turn, the result of the general neglect for the important differences between different forms of ownership (van Griethuysen 2012, Heinsohn and Steiger 2013, Hoffmann 2013, Hodgson 2015, Cole 2015, J.-D. Gerber and J.-F. Gerber 2017), in itself partly due to the neglect of ownership of anything other than resource stocks (see Chapter 3 of this thesis).

Conclusion

In this chapter, I have set out three prominent types of theory of institutional change. Whilst rational choice institutionalism and historical institutionalism are both useful tools for the analysis of institutional change, I have here outlined the argument that evolutionary institutionalism is well placed to

provide further insights into the evolution of ownership institutions with respect to energy resources since it provides a means to integrate both agency, structure, and ecological constraints. Indeed, the use of evolutionary game theory modelling to better understand the evolution of ownership is as old as the method itself, having been used for decades to model the hypothesised possessive behaviour of animals. However, these existing models have focussed on the modelling of this hypothesised possessiveness, and a similar analysis of ownership institutions that structure the transfer of resources has not yet been undertaken. The model in the next chapter represents an attempt to extend the logic of these existing models to the communal, command, and titled property ownership institutions prevalent in human societies.

In doing so, I have identified the 'building blocks' upon which such a model rests. They are as follows. An evolutionary analysis of ownership institutions will require the specification of a population of agents and their strategies, which govern the way in which the agents will interact with each other. Evolutionary processes of variation, selection, and retention will act upon a population of those individuals in accordance with those specifications, and the model I construct reflects how evolution would act upon a population of agents with different strategies defined so that they determine simple strategies of how they interact with their environment and with each other. The overall fitness benefits and losses that result from these strategies with re-

gard to the resources acquired from that environment and with regard to their interactions with others in the population therefore determine which combination of actors within that population are more likely to survive; in other words, the various exogenously given variables defining the fitness benefits and losses incurred through different strategies of interaction with regard to the environment and other agents leads to different populations whose interactions are structured in different ways. The ways in which these populations are structured, then, are to be interpreted in terms of the different ownership institutions that have been hypothesised to govern resources in different societies.

Chapter 6

An evolutionary game theory model of the evolution of ownership

In the thesis so far, I have made a case for why it is important to try to understand why ownership institutions change when energy systems change, argued that the existing literature on this relationship still lacks a mechanism to explain the correlation between energy and ownership, and conceptually defined the four 'ideal type' ownership institutions whose evolution I am

trying to analyse. In this, the fourth chapter, I set out a model of the proposed mechanism. The chapter has four sections. In the first, I begin by comparing the two broad approaches to modelling ownership institutions that correspond with the 'rational choice' and 'evolutionary' institutionalisms set out in the previous chapter, and explain why I have used an 'evolutionary' rather than a rational choice 'economics of property' model. In the second section I discuss the assumptions and limitation of the model. In the third section, I set out the model itself, discussing in turn the intuition behind it, its parameters, the strategies of the agents, and the institutional outcomes that result with agent interactions. In the fourth section, I interpret these outcomes in terms of the four ownership institutions defined at the end of the previous chapter, and suggest that this interpretation provides a framework for empirical enquiry into why different ownership institutions survive to govern different energy resources.

6.1 Why an evolutionary model

There are two broad approaches to modelling the emergence and evolution of ownership institutions: the economics of property approach, and the evolutionary game theory approach (Krier 2009). The economics of property models follow Harold Demsetz's seminal 1967 paper to focus on showing how changes in resource values and transaction costs affect the optimality

of different ownership institutions (Demsetz 1967). Essentially, the intuition behind Demsetz's work is that property rights emerge when the benefits of establishing those rights exceed the costs of doing so, and that this internalises the externalities of using a given resource. Models following this approach apply a cost-benefit analytical framework to different resources to analyse the institutional outcomes, with ownership rights emerging as a response to the economic incentives that come from defining rights over resources. Resource value is typically theorised to change as the resource becomes scarcer, and transaction costs are typically theorised as dependent on the costs of excluding non-owners and the costs of negotiating these rights with others (Ellickson 1993).

The evolutionary game theory approach follows John Maynard Smith (J. M. Smith 1979, 1982) to focus on the results of conflict and repeated interactions between agents, with stable patterns of behaviour interpreted as the emerging social norms of ownership (for example Sugden 1989, Baker 2003, Hafer 2006, and Gintis 2007). The intuition behind these models is that agents use some form of signalling, such as physical possession of a resource, as a conventional cue to settle ownership disputes without resorting to actual conflict, and that ownership institutions emerge as a result. For the purposes of this thesis, there are four main advantages to using an evolutionary approach. Firstly, unlike the 'economics of property' models where agents are motivated by maximising benefits and minimising costs, evolutionary models

need not attribute any form of rationality or even forward-looking behaviours to agents; instead, behavioural change can be theorised in terms of which behaviours are more likely to survive. So the evolutionary model in this chapter is not a rational choice model, since the agents need not be attributed with any form of rationality nor even, necessarily, the capacity to make a choice between strategies; the assumption is only that agents have a strategy of some kind. Some possible strategies, for example a generous or altruistic strategy of unconditional giving to others, would necessarily be excluded by rational choice assumptions, but can be included in an evolutionary model; moreover, such strategies may even prove to be the most likely to survive. Secondly, unlike economic theories that rely on the economic optimality of institutional arrangements to explain their adoption, evolutionary models are able to suggest circumstances in which different ownership institutions are likely to survive even if those arrangements are sub-optimal from a strictly economic perspective (Thebaud and Locatelli 2001). Again, the evolutionary model here makes no normative assumptions about what institutional arrangements agents 'should' choose. Thirdly, economic theories typically assume that the evolution of ownership takes place in the absence of coercion, and for that reason have been described as naive (Eggertsson 1990: 254); since evolutionary models have from their inception incorporated conflict this means that they are well suited to analysing the role of coercion and of power asymmetries in transfers between agents. These asymmetries play an important part in interpreting the model set out below. Fourth,

whilst there is an extensive literature on the evolutionary modelling of the hypothesised possessive ownership amongst animals (for example J. M. Smith and Parker 1976; J. M. Smith and Szathmáry 1997; Kokko, López-Sepulcre, et al. 2006; Alcock 2005; Krier 2009; Stake 2004; Gintis 2009) and humans (Sugden 1986; Krier 2009; Stake 2004; Gintis 2009; Eswaran and Neary 2014; Sherratt and Mesterton-Gibbons 2015, Baker 2003, Hafer 2006) to my knowledge there has been no attempt to extend these models to examine the other forms of ownership more typically practiced by humans, so using this framework is a natural extension and contribution to an already well developed literature.

The model is a deductive model. If the assumptions about the agents and the payoffs are valid then the conclusion that these institutional outcomes will result is valid. However, the purpose of this model is not to deductively prove that the conclusions must follow from the premisses, but to guide empirical research to establish the extent to which the dynamic effects described in the model are also observed in reality. The model, then, is a heuristic that may provide some insight into the possible relationships between the way that agents interact with one another and how changes in these behaviours and in the characteristics of the energy system changes the structure of their interactions; the interpretation of the model suggests some hypotheses that may or may not be supported by empirical investigation. So the outcome of the model should not be understood as a claim that agent behaviour can be

reduced to these simplifying assumptions, but may be better understood as making a conditional proposition: if agents were to behave in this way given these ecological constraints, then we would expect the pattern of interactions between a population of such agents to take the predicted form. Only empirical work can answer the question of whether similar patterns of interaction are actually found in reality.

Related to this point, the relationship between energy systems and ownership institutions is neither assumed nor expected to be deterministic or form a one-to-one correlation. It is an evolutionary model, and the interpretation of the model outcomes represent a range of circumstances in which different populations with various mixes of populations are likely to survive. This clearly does not imply that those behaviours are determined by the energy system, and individuals may continue to behave in preexisting patterns even when their circumstances change; in the terms of the model, institutions may survive even when energetic circumstances change. For example, survivors of a shipwreck might arrive at a desert island and attempt to continue to observe titled property institutions, and though we might expect that they would be more likely to survive were they to spend their energy on hunting and transferring food than if their first actions were to draw up legally enforceable contracts to future income streams, such a society might still, to our surprise, survive. But this idea captures an important part of the spirit in which this evolutionary model of ownership has been constructed: whilst

it is possible to imagine a wide variety of institutional arrangements, not all of those arrangements are equally likely to survive in different environments. Within this model, then, individual behaviours are not determined by social institutions, and social institutions are not determined by the environment; it is not impossible for hunter-gatherers to create titled property institutions, nor for fossil fuelled societies to communally distribute their resources. The utility of the model is to provide some insight into why such exceptions are rare indeed.

6.2 Assumptions and limitations of the model

Based on the intuition behind the model, I have made a series of simplifying assumptions about agents, their interactions with other agents, and the characteristics of the system by which they draw their energy. I list these here, and explain each assumption in turn. In general, the variables are constructed to be as general as possible, so that disambiguation of different manifestations of the factors they represent is left to interpretation and future empirical work; this simplification is typically both a strength of the model in that it makes general principles easier to discern, but is a limitation in that it relegates more nuanced disambiguation of the processes to interpretation of the outcomes and to future empirical work.

Given the simplifications assumed in the construction of the model, the re-

sulting institutional outcomes are representative only of 'ideal types'; no actual society is assumed to have had purely communal, command, or titled property ownership of the type that result from interpretation of the model outcomes. In particular, though many do hypothesise that some animals and humans behave possessively or have possessive instincts (J. M. Smith and Parker 1976; Sugden 1986; J. M. Smith and Szathmáry 1997; Kummer and Cords 1991; Hook 1993; Baker 2003; Stake 2004; Alcock 2005; Kokko, López-Sepulcre, et al. 2006; Hafer 2006; Friedman 2008; Krier 2009; Gintis 2009; Brosnan 2011; Eswaran and Neary 2014; Sherratt and Mesterton-Gibbons 2015), this is explicitly not an assumption or conclusion drawn from this thesis. Again, the applicability of the different 'ideal type' behavioural patterns described by the model remains a matter of empirical enquiry, and nothing in this chapter is to be taken as a claim or assumption that such behaviours actually exist, independently of such empirical observations.

Individuals are the agents within the population

Any model that involves action must specify agents and must allow an interpretation of who or what those agents might be. Strictly speaking, the agents in this model need not be interpreted as individuals. The agents could be interpreted as corporate bodies, or as families, or groups, or any other such thing that could reasonably be thought of as an agent that must consume resources to survive. For the purposes of this thesis, however, the model is

constructed and interpreted to aid analysis of the relationship between energy systems and ownership institutions. The term 'ownership' is defined by most scholars within the literature as the relation between individuals and things, and a critical analysis of that literature was used to produce the working definition of ownership institutions in Chapter 3. Were the agents in the model interpreted to be groups, say, then this would shift the focus of the study away from ownership as those terms are there defined and as they are used in the associated literature upon which I draw. This assumption allows both social structure and individual agency to be represented as contributing to the resulting social institutions, reflecting the way in which social institutions are conceptualised as systems of social rules that structure interactions between agents, and so not reducible to the attributes of agents alone (see, for example, Hodgson 2007: 96). Similarly, social structures cannot exist independently of individuals and their interactions. Simply: ownership institutions cannot be reduced to any attribute of individual agents, since without interactions with other individuals there would be nothing for those institutions to structure.

Whilst an analysis of ownership institutions with actors who are not individuals could be carried out using this framework by interpreting, for example, the actors to be groups or states rather than individuals in order to analyse the transfer of resources as governed by international trade law or by intergovernmental conventions, such an interpretation would be beyond the scope

of the present study. Moreover, some consideration of what such an analysis might look like leads to another pragmatic reason for interpreting the actors as individuals. Since the purpose of this study is to compare institutions in different societies, it is useful to choose to interpret agents in terms that are reasonably comparable between those societies. If I were to take the unit of analysis to be the group, for example, I would find it difficult to justify comparing a group of Hadza with around fifty members to the United States of America with around a third of a billion members. Moreover, it is not clear to me that the group of Hadza couldn't just as justifiably be compared to an extended family in the US, or with an American-based multinational corporation, or with the entire globalised industrial civilisation. This difficulty of specifying units of comparison is largely avoided by choosing the individual as the unit of analysis. An individual Hadza can be compared to an individual citizen of the USA or anywhere else at least in terms of such attributes as the need to consume energy, the need to expend energy to obtain energy, and the fact that energy resources are transferred between those individuals and others individuals with which they come into contact. Since it is these very interactions between individuals that are the object of this study, it makes most sense for the purposes of this particular thesis to interpret the actors in the model to be individuals; the word 'agent' and 'individual' are henceforth used interchangeably in this discussion.

Individuals increase their fitness by consuming resources

All organisms on Earth must consume resources in order to survive. Whilst these resources are not limited to energetic resources, all organisms must acquire sufficient energy to survive since all known living organisms on Earth are carbon based and so must obtain carbon and turn it into biomass in order to continue to physically exist. Energy is required for these processes, whether the organism fixes carbon autotrophically from carbon dioxide in the atmosphere or heterotrophically by consuming other organisms, though of course they would die long before their actual physical disappearance because their biological processes also require energy to function (Smil 2006: 11). Agents that can be consumed by predators or engage in conflict with others in the same population must also expend energy by evading or fighting them in order to survive. All other things being equal, then, an individual that has acquired an energy resource is more likely to survive than an individual who has not.

Different resources increase fitness by different amounts

The model assumes that an agent increases their fitness by consuming resources (by a value v), and that the amount by which their fitness is increased varies depending on the resource. The fitness increasing benefits provided by a resource item are not necessarily reducible to their calorific content; some

foods, for example, may be low in energy but provide rare but vital nutrients. A full interpretation of the increases in fitness associated with different resources, then, requires a full understanding of all the myriad ways in which different kinds of resource increase fitness. It is nevertheless a useful heuristic – not an assumption of the model, but an intuitive means to aid its interpretation – that, all things being equal, acquiring a resource of greater energetic value allows its possessor to do more fitness enhancing activities such as fixing carbon, finding more resources, and avoiding or engaging predators or enemies than acquiring a resource of less energetic value.

There are two ways that an energy resource can be obtained: from the environment or from another individual

Since the purpose of the thesis is to better understand the interactions between individuals that form part of a group, I have assumed a dichotomy between energy resources that are obtained from other individuals within that population, and energy resources that are obtained by any other means; the latter are described as being obtained from the environment. This distinction between the environment and the other individuals in the population is necessary for the interpretation of the model in terms of ownership institutions; to assume otherwise would be to model predator and prey relationships, rather than ownership relations. A model might be extended to include the consumption of other group members, but that would be a model of cannibal-

ism rather than of ownership institutions; such an interpretation is prevented in my model by assuming a distinction between resources derived from the environment and those derived from other agents in the population.

There are costs to obtaining resources

The model assumes that there are costs to obtaining resources from the environment (c). The chemical process of fixing carbon from the atmosphere requires energy, which autotrophs such as plants obtain from the sun. Heterotrophs, including all animals, cannot fix carbon directly and so cannot obtain their energy directly from sunlight, and so obtain their energy by capturing and digesting autotrophs or other heterotrophs. This process requires an initial input of energy (Smil 2006: 11, 25). Even when the source of energy is fossilised organisms or radioactive mineral ore, the same principle applies, since an initial input of energy is required to obtain and process the fuels so that the energy contained in those fossil fuels can be used (Hall and Klitgaard 2012). Due to the distinction made above between obtaining resources from the environment and obtaining resources from other individuals, the model distinguishes between the costs associated with obtaining energy from the environment (c) and the costs of obtaining energy which can incur costs of conflict with other individuals within the group (f); again, this distinction follows from the previous assumption, and is required to maintain the model as representation of ownership rather than of cannablism.

More powerful individuals are more likely to win resource conflicts

Some well known models of the evolution of ownership institutions exclude power asymmetries from their assumptions, with some modellers explicitly acknowledging that they have done so (see Bowles and Choi 2013). Though models assuming such power symmetry are useful in modelling how outcomes between undifferentiated agents might occur, the assumption that such asymmetries do not play a role in the emergence and evolution of ownership institutions has long been criticised as "naive" (Eggertsson 1990).

In this model, power is modelled as the differential likelihood of an agent winning a resource conflict; if their power is absolute ($P = 1$) then they are certain to win any conflict and certain to obtain or retain the resource item they desire or have acquired, but if they are powerless ($P = 0$) then they are guaranteed to lose any conflict and fail to obtain or retain that resource. This operationalisation of power rests on a broad construal of social power as "the ability to produce intended effects", a characterisation originally due to Bertrand Russell (Russell 1938) but one that continues to represent the essence of definitions of the power relationship in the social sciences (Wrong 2017). In the model, power is representative of the agent demanding resources from another individual to produce the intended effect of compliance by that individual. This conceptualisation of power captures well the idea of power as 'coercion by force' (García López et al. 2017), and also extends to

nonphysical resource conflicts couched in hegemonic and counter-hegemonic terms: conflict over norms and ideas is frequently asymmetrical, and include struggles over which norms govern who should transfer resources to whom within a society (Kuzemko 2013, García López et al. 2017). However, this simplification represents a limitation of the model. Since power is represented as the proportion of conflicts won by an agent it is a single unvariegated outcome of the interaction between actors, rather than as the process by which that outcome is reached; in formal terms, the variable P is exogenously given, as are the other four variables that define the model. The model cannot, therefore, suggest any answers to the question 'why do some actors win more resource conflicts than others?'; but it does nevertheless provide a way of framing the question during the interpretation of the institutional outcomes, and for empirical analysis, in terms of the means by which some powerful individuals motivate the transfer of resources from others. Though hegemonic power in a society is not always related to the ability to directly coerce, it often is, not least through the ability to shape norms that might include the legally sanctioned ability to use of physical coercion (Kuzemko 2013); thus, the model must leave this complex disambiguation of the different sources of power to the interpretation of the model outcomes, and to future empirical work.

There may be additional fitness increasing benefits to transferring a resource

The model assumes that there may be some fitness enhancing benefits to surrendering an energy resource to others (b) beyond merely the avoidance of the costs of conflict. As discussed in the second literature review, these benefits have been theorised to include the indirect benefits of maintaining other members of the group to increase variance reduction and group defence as well as direct benefits of receiving increased future returns on resources so transferred. Analytically, this distinguishes the institutional outcomes that result from the variables related to power and conflict from the institutional outcomes that result from direct or indirect benefits of making transfers to others. Again for simplicity, in the model this is represented as a single undifferentiated variable under which various benefits are subsumed, again suggesting ways in which analysis of the different benefits of making transfers may be disambiguated since many different benefits may be present during a single interaction. Again, this lack of differentiation has all the advantages and limitations of simplifying the analysis whilst relegating disambiguation of the different sources of fitness benefits to interpretation and future empirical work.

6.3 The model

The intuition behind the model is as follows. Every individual needs energy resources to survive. There are energy costs to obtaining these resources, and if the costs of obtaining them exceed the returns on their acquisition then the individual will eventually die. There are two ways in which an energy resource can be obtained for consumption: it can be obtained by the individual from the environment, or it can be taken from another individual. This leads to two kinds of cost: the costs of obtaining a resource from the environment, and the costs of conflict with others over the resource. Some individuals are more likely to win conflicts over resources than others. Finally, sometimes, there may be additional benefits to transferring a resource to others, particularly such benefits as the prospect of future reciprocity and of group defence. Depending on the relative value of the resources, benefits, and costs, and depending on the strategies adopted by others, different strategies are more likely to allow an individual to capture more energy. Individuals that capture more net energy are more likely to survive.

The strategies

The strategies that an individual can adopt are these. There are two ways in which an individual can gain possession of a resource: they can demand it from others and fight if necessary (Demand), or they can obtain it from

Table 6.1: List of symbols

D	The Demander strategy
R	The Resister strategy
T	The Transferer strategy
v	Value of the resource possessed by the individual.
c	Cost of obtaining the resource from the environment; $0 < c$.
f	Cost of conflict ('fighting') over the resource; $0 < f$.
b	Additional benefit of transferring the resource.
P	Proportion of conflicts won by a Demander; $0 \leq P \leq 1$.
p	Proportion of D in the population.
q	Proportion of R in the population.
$1 - p - q$	Proportion of T in the population.
$V(X\|Y)$	The change in fitness of X when X interacts with Y.
$W(X)$	The average change in fitness across all of X's interactions.

the environment themselves and fight to defend it if necessary (Resist). A third strategy is to obtain a resource themselves and surrender it if demanded (Transfer). (Note that Demand is similar to the strategy sometimes called 'Aggrandiser' or 'Gangster', Resist is similar to the strategy sometimes called 'Bourgeois', and Transfer similar to the strategy sometimes called 'Dove'; see, for example, the online supplement to Bowles and Choi 2013).

There are five variables. The value of the resource possessed by the individual is represented by v. The cost of obtaining the resource from the environment, always greater than zero, is c. The costs of conflict over the resource, also always greater than zero, is represented by f for 'fighting'. The additional benefits that accrue to a transferer are represented by b; these might include the benefits of increasing the chances of future reciprocation and all the

various benefits of being part of a larger groups, such as increased defence. Finally, the proportion of conflicts won by a Demander range from zero to one, and are represented by P. In terms of these variables, then, the three strategies can be summarised in the following way:

Demand (D): demands a resource of value v from the other player. If the other player resists then there is a fight where D incurs a cost f. Demand wins the fight a proportion P of the time and gains v when it wins.

Resist (R): Obtains a resource of value v at a cost c. Incurs a cost f if fought by a Demander; wins the fight and retains the resource $1 - P$ of the time.

Transfer (T): Obtains a resource of value v at a cost c. Transfers the resource if demanded by a Demander and neither Transferrer nor Demander suffers any cost of fighting. Some additional benefit b is gained by the Transferrer; this b could be the benefits of possible future reciprocation that reduces the risks of unpredictability, or some other benefit of being part of a larger group such as group defense, for example.

The payoffs

The payoffs are calculated in terms of fitness. Fitness is defined in terms of the proportion of agents playing a given strategy that survives into the next generation of a given population.

If a Demander interacts with another Demander then the fitness of neither increases; if a Demander interacts with a Resister then a conflict over the resource ensues and the Demander wins the resource with a probability P; and if a Demander interacts with a Transferrer then no conflict ensues and the Demander receives the entire resource. If a Resister interacts with a Demander then a conflict ensues and the Resister retains the resource with a probability $1 - P$, though has suffered the costs of conflict and of having obtained the resource in the first place; if a Resister meets another Resister or a Transferrer then no conflict ensues and each retains the resource, minus the costs of having obtained it. If a Transferrer meets a Demander then they surrender the resource and suffer the costs of having obtained it, but also receive a gain from having transferred a resource to the Demander; if a Transferrer meets a Resister or another Transferrer then they each retain the resources, minus the costs of having obtained it.

Table 6.2: Payoff matrix for Demander-Resister-Transferrer game

	Demand	Resist	Transfer
Demand	0	$Pv - f$	v
Resist	$(1 - P)v - f - c$	$v - c$	$v - c$
Transfer	$-c + b$	$v - c$	$v - c$

Payoffs are to the row player (on the left).

Since the identity of players does not change the payoffs, subscript i is suppressed; that is, any differences in the ability of agents in winning resources is defined by parameter P, so that all agents playing a given strategy are

affected by a change in the proportion of conflicts that are won by agents playing Demander. This assumption of agent homogeneity in this model is useful for emphasising that different institutional outcomes can result from interactions between agents in different energy settings, independently of any actor heterogeneity. Other sources of heterogeneity, for example differences in the ability of actors to obtain assets from the environment or through inheritance, as well as the way that these differences may affect differences in the proportion of conflicts won by a strategy, are similarly suppressed or subsumed under the existing parameter variables. It would be quite possible to incorporate such heterogeneity into a more complicated variant of this model by modelling the process by which some agents are, for example, more likely to win conflicts than others, and so more likely to survive to play a Demander strategy, with the end result of such complication being identical to that modelled here. To keep the focus on the effect of changes in energy resource characteristics on ownership institutions, such complications are omitted here.

This simple model shows how different values for these variables leads to different mixes of strategies in the population. These are represented by the proportion p in a population that adopts Demand, the proportion q that adopts Resist, and the proportion $1 - p - q$ that adopts Transfer. For calculating the way these proportions increase or decrease in a population, $V(X|Y)$ denotes the increase in fitness that results from an interaction be-

tween strategy X and strategy Y, and $W(X)$ denotes the average change in fitness across all of strategy X's interactions, which in turn depends upon the proportion of each of the other strategies in the population. So the outcome of each interaction can be listed as:

$$\begin{array}{lll} V(D|D) = 0 & V(R|D) = (1-P)v - f - c & V(T|D) = -c + b \\ V(D|R) = Pv - f & V(R|R) = v - c & V(T|R) = v - c \\ V(D|T) = v & V(R|T) = v - c & V(T|T) = v - c \end{array}$$

The payoffs for an individual playing each strategy is the result in terms of increased fitness that accrues to that individual when they interact with another player. That is, the average fitness is the sum of the fitness increases that result from the interactions with individuals adopting different strategies multiplied by the frequency with which those strategies occur in the population. So, for example, the average increase in fitness for a Demander is the sum of the payoff an individual receives from interacting with another Demander multiplied by the chances of it meeting another Demander, plus the payoff from interacting with a Resister multiplied by the chances of it meeting a Resister, plus the payoff from interacting with a Transferrer multiplied by the chances of it meeting a Transferrer. So, for each of the three strategies:

$$\begin{aligned} W(D) &= pV(D|D) + qV(D|R) + (1-p-q)(D|T) \\ &= q(Pv - f) + (1-p-q)v \end{aligned} \tag{6.1}$$

$$\begin{aligned} W(R) &= pV(R|D) + qV(R|R) + (1-p-q)V(R|T) \\ &= v(1-pP) - pf - c \end{aligned} \tag{6.2}$$

$$\begin{aligned} W(T) &= pV(T|D) + qV(T|R) + (1-p-q)V(T|T) \\ &= (1-p)v + pb - c. \end{aligned} \tag{6.3}$$

Replicator dynamic and difference equation

The replicator dynamic is used to calculate the strategy mix in a population based upon the proportions in the preceding population and the relative fitness of the strategies. In this model, the replicator dynamic for a two strategy game between Demanders and Transferrers, where p' denotes the proportion of D in the succeeding population, is:

$$p' = \frac{pV(D)}{pV(D) + (1-p)V(T)} \tag{6.4}$$

from which the difference equation can be derived (see McElreath and Boyd 2008: 26):

$$\Delta p = p(1-p)\frac{W(D) - W(T)}{pW(D) - (1-p)W(T)}. \tag{6.5}$$

Generally, transmission mechanisms between successive populations are classified as either genetic or cultural (or, equivalently, vertical or horizontal). This model makes no assumptions about which transmission mechanisms are in operation, as it may be that a trait towards generosity can be genetically inherited or culturally learnt or a combination of the two. This serves as a nice concrete example of why a rational choice model would be unsuitable here, since actions based on genetic predispositions are not generally thought to be rationally chosen.

Game outcomes

In the model, the possible stable outcomes of these interactions are a population entirely composed of one of the three strategies (in which one strategy

dominates), or a population in which two or more of these strategies are mixed (in which there is coexistence). These different outcomes are interpreted to correspond with the different ownership institutions adopted by a population.

A population composed entirely of Demanders obtains no resources from their environment, so individuals in such a population would not survive. As a result of the risk of Demander takeover leading to population collapse, an intuitive way of interpreting the role of ownership institutions in different societies is that they prevent a situation in which Demand is the best unique strategy, since if that were to occur then such a population would collapse.

The different game outcomes can be interpreted to correspond to the four different ownership institutions. First, a possession institution exists when a population is largely composed of Resisters who are able to prevent invasion by Demanders. Second, a communal ownership institution exists in a mixed Demander-Transferrer population where the invasion of Resisters is prevented by sufficiently high additional benefits accruing to Transferrers. Third, a command ownership institution exists in a mixed Demander-Transferrer population in which the invasion of Resisters is prevented by the increased likelihood of Demanders winning fights. Fourth, titled property is formally similar to communal ownership in this model in that it is composed of a mixed Demander-Transferrer population, but my interpretation of the

two outcomes differs in the nature of the kinds of benefits that Transferrers receive for surrendering their possessions. One way to formalise the difference would be to distinguish between communal ownership where the benefits to Transferrers derive from the fact that resources are relatively low in value so that survival depends upon reciprocity to reduce the costs of unpredictability, and titled property where the benefits to Transferrers derive from the way that much high value resources are shared; that is, in titled property, the invasion of Resisters is prevented by the existence of sufficiently high values of v to allow sufficiently high additional benefits to accrue to Transferrers. These interpretations are discussed in more detail below.

It is worth noting that a mixed Demander-Resister population represents the absence of an ownership institution: Resisters obtain resources from the environment and then fight over them with Demanders. It is intuitive to expect that populations observing some form of ownership institution engage in less wasteful conflict, and that individuals in those populations are more likely to survive; it is this very insight that motivated the modelling of the origins of possession institutions as coordination games in the first place (J. M. Smith 1979, 1982).

A situation in which a population of Resisters can repel invasion by Demanders can be found by examining the two-by-two payoff table for interactions between Demanders and Resisters.

If the payoffs to Resisters are always greater than payoffs to Demanders,

Table 6.3: Payoff matrix for Demander-Resister game

	Demand	Resist
Demand	0	$Pv - f$
Resist	$(1 - P)v - f - c$	$v - c$

Payoffs are to the row player (on the left).

Resisters will dominate and repel any invading Demanders. This occurs when $(1 - P)v - f - c > 0$, and when $v - c > Pv - f$. The second of these inequalities can be rewritten $(1 - P)v + f - c > 0$; since $f > 0$, Resisters can repel Demanders as long as $(1 - P)v - f - c > 0$. Solving for v:

$$\begin{aligned} 0 &> Pv + f + c \\ v &> \frac{f + c}{1 - P}. \end{aligned} \tag{6.6}$$

This inequality will no longer hold if the relative power P of Demanders decreases and the costs of fighting over resources f increases, for example if hunting tools become used as weapons, or if the costs of obtaining resources c increases, for example if more energy expenditure is required for hunting, say, than foraging for smaller resources. It is also worth nothing that although in the short term the value v of the resource possessed by an individual may be large – for example, a single large animal can provide much more energy than can be consumed by an individual – if the resource quickly declines in value, for example if the elephant meat quickly declines in value through spoilage,

then this rapid decline in value over the short terms also means that very soon $v > \frac{f+c}{1-P}$ no longer holds. The spoilage of resources is not modelled here, as it would add a temporal component to the model which would increase the complexity of the model without adding much in the way of analytical insight.

In terms of the model, a mixed Demander-Transferrer population can avoid collapse into a Demander dominated population as long as Demand and Transfer can coexist and converge upon a mixture of the two strategies.

Table 6.4: Payoff matrix for Demander-Transferrer game

	Demand	Transfer
Demand	0	v
Transfer	$-c+b$	$v-c$

Payoffs are to the row player (on the left).

For there to be bistability around a convergence point, the two inequalities $v > v-c$ and $-c+b > 0$ must hold. Since $c > 0$, the first of these inequalities always holds, so for Demander-Transferrer bistability, the benefits of transferring must be greater than the costs of obtaining the resource in the first place, that is, when $b > c$.

Moreover, such a mixed Demander-Transferrer population must be able to repel Resisters who fight to prevent their resources being taken; that is, at the point where Demanders and Transferrers are in a stable equilibrium, both strategies must be fitter than Resisters. To find the conditions in which a mixed Demander-Transferrer population can repel invading Resisters, the

equilibrium point of the Demander-Transferrer strategy must first be found. This is where $\Delta p = 0$, with that equilibrium point denoted by $\hat{p}$. To find $\hat{p}$, we set $p = \hat{p}$ and $W(D) = W(T)$ and solve for $\hat{p}$ (remembering that $q = 0$):

$$\begin{aligned} W(D) &= W(T) \\ q(Pv - f) + (1 - \hat{p} - q)v &= (1 - \hat{p})v + \hat{p}b - c \\ \frac{c}{b} &= \hat{p}. \end{aligned} \tag{6.7}$$

So, a mixed Demander-Transferrer population has a stable internal equilibrium when $b > c$, where the proportion of Demanders in the population is c/b. At that point, a rare Resister can invade if it is fitter than the Demanders and Transferrers in the population. Since Demanders and Transferrers are equally fit at that point, Resisters can be prevented from invading as long as $W(D) = W(T) > W(R)$, when $q = 0$, and $p = c/b$. This occurs when:

$$\begin{aligned} W(D) &> W(R) \\ (1 - p)v &> v(1 - pP) - pf - c. \end{aligned} \tag{6.8}$$

This inequality may be maintained when b is sufficiently large; for example,

if resources are highly unpredictable and individuals in the group at high risk of attack by predators, then the benefits of unpredictability reduction and continuing membership of the group are sufficiently fitness enhancing. To find the level at which b is sufficiently large for the communal ownership institution to survive, we first solve for p:

$$\begin{aligned} (1-p)v &> v(1-pP) - pf - c \\ p &< \frac{c}{v - Pv - f} \end{aligned} \tag{6.9}$$

then substitute c/b for p:

$$\frac{c}{b} < \frac{c}{v - Pv - f} \tag{6.10}$$

and then solve for b:

$$\begin{aligned} cb &> c(v - Pv - f) \\ b &> (1-P)v - f. \end{aligned} \tag{6.11}$$

So, to repel invasion by Resisters, the additional benefits accruing to Transferrers must be larger than $(1-P)v-f$. So, taken together, the conditions in which such a society can maintain a mixed Demander-Transferrer population is when $b > c$ and $b > (1-P)v - f$.

In some societies resources are more predictable, for example where smaller but more consistent 'r-selected' species are gathered (Hayden 1981), or where domesticated produce and the ability to store resources reduces the unpredictability of the energy supply. If the benefits of surrendering resources, b, falls below $(1-P)v - f$, the mixed Demander-Transferrer population no longer repels invasion by Resisters. A return to a population dominated by Resisters can occur as long as there are conditions in which a population of Resisters can repel Demanders; as above, that is when $v > \frac{f+c}{1-P}$.

An alternative possibility is that such a society may maintain a Demander-Transferrer mix by the suppression of Resisters by more powerful Demanders. This can occur when P is sufficiently large to make Demanders and Transferrers fitter than Resisters. Again, the conditions for a stable Demander-Transferrer population are that $c > b$ and $b > (1-P)v - f$. Solving for P:

$$\begin{aligned} b &> (1-P)v - f \\ P &> 1 - \frac{f+b}{v}. \end{aligned} \tag{6.12}$$

So as long as P remains high relative to the costs of fighting and the benefits of transferring, this represents the conditions in which a mixed Demander-Transferrer population can prevent the invasion of Resisters through asym-

metries in the ability to win resource conflicts. This can be interpreted as the condition in which extractive command ownership institutions arise, whereby powerful individuals are able to Demand resources from the Transferrers who obtain them from the environment whilst repelling Resisters willing to fight to try to retain the resources they have obtained.

A further possibility for suppressing Resisters is to increase the benefits of Transferring. In terms of the model, this works by making b sufficiently large to make Transferrers fitter, and so prevent Resisters invading the mixed Demander-Transferrer population. This mechanism may operate in conjunction with Demanders increased chances of winning conflicts to repel them, since the condition in which Resisters are repelled is $P > 1 - \frac{f+b}{v}$, if b increases then the value of P need not be as high to ensure that invasion by Resisters is prevented. This can be interpreted as representing the way that mutually beneficial contracts begin to replace direct coercion as the means by which Resisting is prevented and Transferring encouraged; again, such an interpretation is discussed in more detail below.

6.4 Interpreting the model

Possession, as defined in this thesis, is where an item is not taken if it is already possessed by another. In terms of the model, I interpret a population dominated by Resisters, who engage in conflict whenever a resource

is demanded from them by a Demander, as representing the institution of possession. This accords well with the definition of the possession institution, since in the model agents who attempt to take resources from others – Demanders – are less likely to survive than Resisters who do not take resources from others, and as a result resource transfers between agents do not occur. In other words, those who obtain resources from the environment do not transfer those resources to others: they maintain possession of those resources.

Communal ownership is where initial possessors transfer what they possess to other members of the group; that is, it is community membership, not initial possession, that entitles an individual to those items, even if those items are initially in the possession of another. In terms of the model, I distinguish this institutional outcome from the 'possession' outcome because there are no longer any Resisters in the population: agents in this population surrender their resources to those that demand those resources from them. What allows this increase in the proportion of agents adopting Transfer and Demand strategies in the population is that an increase in the benefits of transferring resources increases the fitness of those surrendering and demanding resources relative to those who resist such resource transfers; that is, Resisters who fight to maintain possession of their resources are less likely to survive than Transferrers and Demanders because there are, now, benefits to transferring without resistance.

Command ownership is where initial possessors transfer what they possess to an agent of higher status; that is, it is status, rather than group membership or initial possession, that entitles an individual to those items. Like communal ownership, the population is a mix of Demanders and Transferrers from which Resisters are repelled. However, unlike communal ownership, Transferrers are not made fitter by an increase in the benefits of group membership, but through the likelihood that Demanders will win conflicts over the resources that Resisters possess. This reflects the fact that command ownership institutions such as serfdom and slavery are maintained by the threat of direct coercion; a slave or a serf is very unlikely to win a resource conflict with their master or lord, and surrenders their possessions to them.

Titled property is where initial possessors surrender what they possess to those with a legal title to those possessions; that is, it is contract rather than status, group membership, or initial possession that entitles the receiver to receive those items. Like communal ownership and command ownership, this again differs from possession institutions in that Resisters are repelled, and Transferrers and Demanders make up the population; this captures the way in which those adopting titled property institutions rarely consume things that they actually obtain themselves, and instead obtain those resources by entering into contracts with others. Titled property differs from command ownership in that the ability to win conflicts plays a less important role than the accruing of benefits to those who transfer. This reflects a shift

from a command institution in which resources are transferred to specific individuals as determined by their status (who, were there a conflict, would be likely to win those resources anyway) to a titled property institution in which resources are transferred to any individual with whom the possessor of the resource has contracted.

As noted above, it is an interesting feature that communal property and titled property share a formal similarity in the model since in both outcomes it is the accrual of benefits to Transferrers, rather than the ability of the Demander to win conflicts, that makes Transferring and Demanding more successful strategies than Resisting. My interpretation of the distinction between the two outcomes rests on an interpretation that different kinds of benefits result from adopting communal ownership and from adopting titled property. In the case of those adopting communal ownership institutions, I have interpreted the benefit as being largely due to transferring resources now increasing an individual's fitness by increasing the chances that others will transfer resources to them in the future. In the case of titled property institutions, I interpret the benefits as largely due to the accrual of more benefits to individuals who enter into contracts than to those who do not enter into such contracts.

This distinction between the benefits of a general 'attitudinal reciprocity' among those who adopt communal ownership to a more 'calculated reciprocity' among those who adopt titled property is important for identifying

the characteristics of the energy systems in which these different institutions are more likely to survive. Above, I have suggested that the key benefit of communal ownership as the reduction in the unpredictability of the energy flow. My interpretation of the benefits of titled property differs from this, since the definition of titled property is that "initial possessors surrender what they possess to those with a legal title to those possessions", not to those who are simply members of the group. This distinction is crucial for two reasons. First, under titled property, agents acquire titles to resources by entering into contracts which specify exactly who will surrender what to whom. This exactness, when combined with some degree of freedom to choose with whom to enter such contracts, leads to the second important difference: since agents have a contract stipulating what will be surrendered to them in the future, they can calculate that they will receive greater benefits if they enter into contracts with those who contract to supply them with higher returns. A good example of such 'calculated reciprocity' is the loan contract, an important form of titled property where one individual transfers some specified quantity of a resource to another individual on the condition that at some specified future date the debtor will surrender to the creditor a larger amount as repayment and interest. As a consequence of the expectation that the creditor will receive interest as well as repayment – or, more generally, that at least one party to the contract will receive more than they initially gave – titled property institutions are more likely to survive where the loaned resources can be used by the debtor to yield a greater return.

Aggregated across a nonshrinking population, such transfers can only persist whilst economic expansion occurs. To the extent that economic processes rely on inputs of energy flows, economic expansion can occur during periods of territorial expansion as more territory supplies more resources for further expansion, or can occur where nonbiomass fuels supply more energy for exploration and extraction of ever more nonbiomass fuels; both such energy systems can even grow exponentially, for a time.

Conclusion

In this chapter I have set out an evolutionary game theory model of the mechanism by which ownership institutions change when energy systems change. Having explained in the first part why an evolutionary model is appropriate, in the second section I set out the assumptions and limitations of the model, in the third set out the model itself, and in the fourth I explained my interpretation of it. In the next chapter, I use this interpretation to frame a narrative of how titled property institutions have evolved, and to examine the circumstances in which they have survived.

Chapter 7

The evolution of titled property

Introduction

This narrative of the evolution of titled property is a story of recurrent cycles as well as continuity. Originating in the commercial transactions of ancient Mesopotamia, the extension of titled property contracts from commercial contracts to agricultural loans has repeatedly resulted in impoverishment and social unrest, first in Mesopotamia itself, then in ancient Greece, republican and imperial Rome, and then later still in modern Europe. Alongside is a more continuous narrative of the accrual of theories about how to avoid these recurrent social problems; modern theories rest upon distinctions established

by the philosophers of the European Middle ages, who in turn draw upon classical Greek, Latin, and Hebrew texts, the last of these in turn recording practices borrowed from the ancient Mesopotamians themselves. Two trends emerge: that titled property tends to survive only where there is a growing energy base; and that the key to avoiding the disorder that accompanies titled property, if it can be found at all, may lie in successfully making a distinction between property contracts that are socially beneficial from those that ultimately harm us.

7.1 Mesopotamia

The key characteristic distinguishing titled property from communal or command ownership is that, instead of resource transfers being governed by community membership or status, such transfers are governed by contracts. Unlike the generalised reciprocity between gift-givers or the transfers from slave and serf to master, transfers of resources governed by titled property contracts stipulate a precise amount that is to be transferred, and at a precise date.

Titled property contracts have their origin in ancient Mesopotamia, first appearing during the fourth millenium BC. Clay tokens representing goods such as jars of oil, sheep or goats, ducks, grain, bread, and beer had begun to be used probably for accounting purposes, after developments including

the plough and copper tools had allowed an increase in agricultural surpluses (Oppenheim 1959, Schmandt-Besserat 1986b, 1992, 2003, Mattessich 1989, Carmona and Ezzamel 2007: 182). Around 3500 BC, the earliest known property contracts were developed in Mesopotamia by the Sumerian civilisation, contracts that took the form of some number of these small tokens baked inside a larger hollow sphere of clay or 'envelope' (Schmandt-Besserat 1980: 359, Mattessich 1989: 75). Probably originating with trade contracts in which the temple or the palace would entrust a merchant with the care of some goods for sale elsewhere, the contents of the envelopes records the quantity of goods with which a merchant traveller has been entrusted (Mattessich 1989). It was a small intellectual step from thinking of such objects as permanent records of future transfers to thinking of them as being formal loan agreements, or IOUs, in which merchants were entrusted with some goods with the expectation that they would return from their trade voyages with goods of a higher value (Mattessich 1989: 76, Schmandt-Besserat 1986a: 34). As early as 3250 BC, the trustee began to be identified by name on the envelope (Schmandt-Besserat 2003, Carmona and Ezzamel 2007: 185) and the token started to be impressed onto the outside of the envelope before baking, which allowed the contents to be known without having to break the envelope. Since it was no longer necessary to keep the token inside, flat clay tablets eventually took the place of the envelope, and the use of tokens for imprinting gave way to graphics made with a wedge, and then on to the earliest cuneiform writing. The essence of titled property is that there be a

written title; all the evidence suggests that writing in fact first developed in order to write these earliest property contracts (Schmandt-Besserat 1986b, Schmandt-Besserat 1992).

In addition to engaging merchants for commerce, Sumerian palaces and temples also operated a system of land-leasing or sharecropping, demanding obligation payments from the peasant farmers that worked the land (M. Hudson 2000: 142, 145). Extending the principle of the property contract from their commercial investments to their agrarian income, palaces and temples came to consider the seeds and animals the farmers used as loans to be repaid at harvest time (M. Hudson 2002: 49). It seems that, just as the palaces and temples had expected a fixed rate of taxation, they also fixed an expected level of interest on the agricultural loans made to farmers. Since these farmers owned very little, they were obliged to pledge themselves and their family members, who would be enslaved in the event that they were unable to pay off their debts (M. Hudson 2002: 49). The rates charged to farmers was determined not by what was realistic for them to repay, but was set to match the rate at which they had previously had to pay their obligations. As the economist Michael Hudson describes it, "archaic usury was an extortionate phenomenon" (M. Hudson 2000: 140), with the mechanism of debt and repayment operating in very much the same way that taxes and sharecropping obligations had previously functioned to extract surplus from the peasant population. Although the Sumerians knew very well that barley crops and

animal herds did not increase at an annual rate anywhere near 33.3 per cent, this was neverthless the rate of repayment that was demanded of farmers by palaces and temples, equal to the percentage that they previously extracted from sharecropping (M. Hudson 2000: 144, Jursa 2002, Wunsch 2002). Interest was calculated at a rate set for administrative ease: every month, the amount of debt increased by 1/60th, the smallest unit in the Sumerian's sexagesimal numeral system (M. Hudson 2002: 27).

The ancient Mesopotamians are quite likely to be the first and only civilisation in history to have invented loans at interest. This is contrary to the popular view that interest on loans is a human universal across agricultural communities as lenders expect to receive more back in return at the harvest, a view perhaps originated by Marcel Mauss (1925) and certainly popularised by him and by Fritz Heichelheim (Heichelheim 1938: 54f; for discussion see also M. Hudson 2002). Interest bearing loans and compound interest were unknown to Germans as late as the first century AD (Tacitus *Germania* 26), and Hudson suggests it is safe to assume that this was true of Europe quite generally (M. Hudson 2000: 146). In India around the end of the fourth century BC, Megasthenes, the Greek envoy to the city of Pataliputra is supposed to have reported that the Indians do not lend at interest and that creditors unable to recover a loan have no recourse to law, only having themselves to blame if they had made a loan to an untrustworthy debtor (*Indika*: 27 B and C). In China, the first reliable reference to interest-bearing loans

occurs in the fourth century BC, and though their origins remain obscure, the practice seems soon to have spread (Yang 1952, Graeber 2011: 425n29). In pre-Colombian South America, the economically sophisticated Aztecs are reported in 1546 to have no knowledge of interest, with loans made without charge and debtors giving merely their word or, at most, a pledged guarantee (MacLeod 1925: 455n4). In North America, the only potential candidate of a case where loans were made at interest appear in the early reports of the Kwakiutl (or Kwakwaka'wakw) and to a lesser extent some neighbouring groups, whose practices had inspired Mauss and Heichelheim to their generalisation that all pre-industrial societies must have had some concept of interest. Yet the loans at interest practiced by the Kwatiutl was a form of competitive exchange involving woolen blankets (M. Hudson 2002: 12, 42), and the fact that the practice had not spread particularly far suggests that it might even have been the result of relatively recent cultural diffusion from early European settlers (MacLeod 1925: 455). Similarly, the so called 'primitive capitalist' groups of Papua New Guinea, the Kapauku and the Tolai, though recognised to have developed indigenous economic systems involving shell money, exchange, internal markets, and some degree of economic specialisation, also did not practice loans at interest (Pospisil 1958, A. L. Epstein 1969).

By around 2500 BC[1], Mesopotamian interest rates are denominated in barley as well as silver, essentially setting up a rate of equivalance or exchange

[1]All dates according to the Middle Chronology.

between the two (Archi 2002, Steinkeller 2002). The first calculations of expected agricultural performance appear in the historical record, with one document calculating the outcome of cattle breeding over a ten year period assuming a zero mortality rate, and the resulting cheese converted into silver (Carmona and Ezzamel 2007: 189). Reforms in the 24th century BC set crop obligations and taxes payable in barley or silver by professions including surveyors and brewers as well as cultivators (M. Hudson 2000: 144). By the 21st century BC households as well as large institutions were engaged in money-lending for economic gain (Garfinkle 2004). Foremen, employing gangs of agricultural labourers, held accounts that were almost always overdrawn, since the rate of their loans had been fixed at the optimistic maximum that the foreman could expect to extract from his workers (Nissen et al. 1993: 54, Carmona and Ezzamel 2007: 187). After 60 months a loan 'matured', since interest accruing at the rate of one sixtieth per month would double the debt and produce a new debt the same size as the original loan; once matured, interest would also be charged on the interest (M. Hudson 2000: 147). These debts had to be settled at all costs; even death could not absolve these debts, since the death of an endebted foreman would result in the confiscation of his possessions, and members of his household could be taken into the royal labour force to perform the kind of work that the dead foreman had previously overseen (Nissen et al. 1993, Carmona and Ezzamel 2007: 187).

From the end of the 3rd millenium BC, however, the charging of interest on agrarian loans had begun to have a negative effect on social cohesion. Throughout the period 2400-1600 BC, rulers proclaimed 'clean slates' in which debts were forgiven (Akkadian: *misarum*) and the enslaved allowed to return to their place of origin (*andurarum*), effectively reasserting the royal right to the agricultural surpluses and overriding the claims of the creditors (Lemche 1979, M. Hudson 2000, M. Hudson 2002: 52). The laws of the Third Dynasty of Ur (2112-2004 BC) and the edicts of Hammurabi (r.1792-1750 BC) and Ammisaduqa (r.1646-1626 BC) all include such provisions. Of these, the Edict of Ammisaduqa, dating from around 1646 BC, is the most complete extant example. With sufficient detail to close a number of loopholes that creditors had previously used to avoid having to surrender their titles, the edict proclaims on pain of death that all debts should be cancelled for the whole population, with the exception of debts incurred to obtain a profit or in the course of commercial travel, and ordered the freeing of people from various towns who had become enslaved because of their own debt or that of their family members (Lemche 1979: 12). It seems likely from the dates of the edicts that rulers would cancel debts upon assuming the throne, and in the case of longer reigning kings such as Hammurabi again after 30 years, or a 'month of years' into their rule (M. Hudson 2000: 148, 2002: 40). These edicts restored prior land usage rights to cultivators, the rights to collect rents to royalty, and preserved a body of free men that could be called upon for defence in times of war (M. Hudson 2002: 52). It may also have

enhanced the status of the ruler in the cyclical Mesopotaniam cosmology, symbolically endowing them with an ability to reset time (M. Hudson 2002: 52). For a thousand years, from the laws of the Third Dynasty of Ur until the first millenium BC, the rate of interest rarely wavered from one sixtieth per month, and the problem of unpayable debt repeatedly was resolved by the periodic declaration of clean slates (M. Hudson 2000: 142n18). The ancient Mesopotamians had established a system of proto-titled property in which interest, and even compound interest, could be charged on loans to debtors who would lose their land and their liberty if they defaulted, a sytem kept viable by rulers periodically annulling the accumulated titled of creditors, wiping the slate clean and returning the enslaved indebted to their origins, thereby beginning the cycle anew (Kramer 1959: 35, 79, 83, M. Hudson 2000: 138n13).

As tends to be the case with evolutionary mechanisms, the transition from command ownership to titled property begins with the first of a series of almost imperceptible shifts. In ancient Mesopotamia, this shift from obligation payments to debt *re*payments is subtle, but fundamental. Whereas under command ownership the paying of an obligation is a single transfer of resources from the possessor of a resource to an individual of higher status, under titled property institutions the *re*payment of a debt involves an initial transfer from the creditor to the debtor followed later by the transfer of the satisfaction of that loan from debtor to creditor. So whilst the quantities

actually transferred may not differ, the conception of who owns what has profoundly changed: instead of a command ownership system in which a proportion of a peasant's possessions come to be owned by their lord, under titled property all of a debtors possessions up to the satisfaction value of the loan can potentially become the property of the creditor.

Just as importantly, whereas under command ownership institutions an obligation payment is of a fixed amount or a proportion of a harvest, under titled property systems the repayment of a debt, motivated by the promise of repayment plus interest, will always be a sum greater than what has been loaned. Indeed, Gunnar Heinsohn and Otto Steiger clearly identify titled property, and the interest that accrues upon loans of such property, as the reason for increases in economic activity, writing that "The demand for a rate of interest forces upon [the debtor] a value of production, expressed in terms of quantity, time, money or price, which must be greater than the money proper advanced as capital. This demand thus necessitates a value surplus in the production of commodities, the rate of *profit*" (Heinsohn and Steiger 2003: 511, emphasis in original). Unlike a fixed tax or a proportional obligation payment, then, with the adoption of titled property the need to repay interest motivates the debtor to harvest a greater surplus, to increase their economic output (Georgescu-Roegen 1976: 98). Aggregated across a non-shrinking population, this implies economic growth; and, indeed, the adoption of titled property has been identified by many prominent theorists

as a key correlate of economic growth (Betz 2008 serves as a overview of several).

As the ancient Mesopotamians discovered, however, there are limits to the repayment of interest by individuals engaged in agriculture. Aggregated across all the individuals active in an economy, this implies that there are also limits to economic growth that is possible in an economy whose energy inputs derive almost entirely from the conversion of energy from the sun into biomass. Indeed, economic growth theorists have long tended to focus on the increases that are possible from using inputs more efficiently, with the growth models from Adam Smith and Ricardo to Solow and Kaldor either explicitly or implicitly assuming that input levels are fixed and that the effects of specialisation, economies of scale, and gains from trade are what allow economic growth to occur (Daly 1974a). In the case of the ancient Mesopotamians, an example of such 'efficiency growth' is the aggregated profits of merchants, whose activities allow the economic output from one place to be traded for commodities from elsewhere that had been produced using fewer inputs. The difference between the levels of input required to produce a good in one place rather than another – that is, the 'comparative advantage' of one place over another – allowed these merchants to gain enough from those trades to return with some profit and enough to cover the repayments on any commercial loans. Indeed, the rulers of ancient Mesopotamia had never had cause to prohibit or write off such commercial loans, explicitly excluding commercial

debts from their clean slate proclamations. With agricultural loans, however, the limits to such 'efficiency growth' in which inputs are used more efficiently to produce greater outputs seems to have much more quickly been reached: technological innovations, and the intensification of cultivation and labour, have only limited potential to convert more of the light from the sun and nutrients from the soil into agricultural produce. Especially once interest is compounded, such loans prove much harder to repay; after all, compounded interest increases exponentially, but grain and animals clearly cannot.

Powerful enough to impose their will upon creditors, Mesopotamia's rulers periodically wiped the slate clean by granting remission on agrarian debts. Though this system had survived for perhaps a thousand years, by the first millenium BC, and possibly already in the period leading up to the Sack of Babylon in 1595 BC, Mesopotamian rulers had gradually lost their power to annul the titles acquired by creditors (M. Hudson 2002: 14). Though rulers continued to proclaim clean slates, these retained a largely symbolic function, and no longer had the redistributive effects they had had before (M. Hudson 2002: 14).

7.2 Ancient Greece

The charging of interest appears in the civilisations of Greece and Etrurian Italy during the eighth century BC, likely due to the influence of Syrian

and Phoenician merchants (M. Hudson 1992, M. Hudson 2002: 41). Before then, the poet Hesiod still writes of interest-free seed loans repayable in kind (Homer and Sylla 1996; 33), and much earlier Linear B records dating from before 1200 BC give no indication of interest being charged on loans in Mycenean Greece (M. Hudson 2000: 146). However, the Linear B records do enshrine the right of land owners to protect their land against disappropriation even by public authorities (L. R. Palmer 1958, Shelmerdine 2011), emblematic of the shift that took place at the end of the Bronze Age, as the authority of the palaces was weakened and wealthy families gained in strength (Morris 1996).

However, without a strong central authority with the ability to cancel debts and redistribute land, the arrival of interest also brought with it the familiar problem that some debts soon become impossible to repay. Though reciprocal interest-free borrowing continued, interest-bearing loans including rural loans also became widespread (Millett 2002: 219-220). Debtors unable to pay their creditors might lose their land and become sharecropping *hektemoroi*, and if they had pledged their labour as security could also lose their freedom, sometimes even being sold into slavery abroad. By the seventh century, these conseqences had already caused crises in a number of Greek city states, and in Sparta, Corinth, Sicyon, Megara and elsewhere had resulted in popular revolts and the overthrow and exile of the ruling oligarchs, often with a tyrant establishing themselves as ruler in a move frequently welcomed by the poorer

citizenry (Wallace 2007: 51-52, Murray 1993: 137-139).

In Athens in the early sixth century, the lawmaker Solon was granted the authority to enact the reforms he deemed necessary to prevent clashes in Athens similarly escalating into outright civil war. According to later reports by either Aristotle or one of his students, Solon's reforms of 594 BC cancelled all debts, the so-called *seisachtheia* or 'shaking off', and outlawed debt bondage and dependent labour among Athenians (Wallace 2007: 59, 73; *Constitution of the Athenians* 13.3). However, the public authorities had only been endowed with sufficient power to enact a single Mesopotamian-style 'clean slate'; within a generation "hatred of the rich" led the poorer Athenians to support a populist called Peisistratus in his bid to become tyrant of Athens in 561 BC (Arist. *Politics* 1305a). Though a tyrant, the influence of Solon's reforms seems to have remained sufficiently strong, and Peisistratus is supposed to have "administered everything according to the laws" (*Const. Ath.* 16.8; also Herodotus 1.59.6, Thucydides 6.54.6, Wallace 2007: 76). He also is reported to have assumed the role of providing loans to assist with farming, and appears not to have charged interest, instead issuing loans partly in the expectation that improved yields would increase the tithes that he levied on the produce (*Const. Ath.* 16.2-4). Peisistratus's son Hippias succeeded him in 528 or 527 BC, possibly partially ruling with his brother, but was ultimately forced into exile in 510 BC (*Const. Ath.* 18 and 20) after which a new and more democratic constitution was adopted (*Const. Ath.* 22). The cycle

in which one set of oligarchs would be replaced by another set of oligarchs increasingly gave way to calls that ever more decision-making power be given to all the male citizenry, demands increasingly acceded to, resulting in the ever greater democratic participation of free males, whilst institutionalising the unequal status of women and of slaves (Morris 2004: 732).

The Constitution of Athens was by no means unique; in total 158 Greek city states enacted similar reforms around that time (Wallace 2007: 49). Indeed, much of Aristotle's work, particularly his *Politics*, is focussed on understanding and interpreting the principles behind the constitutional reforms that had occurred in the centuries before he was born in an effort to understand the factors that make a constitution more or less likely to survive. Among Aristotle's conclusions is that the charging of interest on loans is unfavourable to constitutional survival. Whilst Plato had previously condemned charging interest on the grounds that it created a group of aggrieved indebted and disenfranchised citizens and thereby weakened the state (*Laws* 5.742, *Republic* 8.555), Aristotle went further. In an argument that would greatly influence future debates, Aristotle describes the charging of interest as altogether unnatural, writing:

> usury is most hated, and with the most reason, because it makes a gain out of money itself and not from that purpose for which it was invented. For money was created for the purpose of exchange, not to increase at interest. And this is the actual origin of the

> Greek word [*tokos*]: offspring resembles a parent, and interest is money that is born from money. Consequently, this method of getting wealth is of all methods the most unnatural (trans. H. Rackham, square parentheses my own)

Taking Aristotle's argument to be that there should be different rules governing the use of different kinds of things because they have different characteristics, this is the earliest extant precursor, I think, to the argument that there should be a distinction made between living resource stocks from which a consumable resource flows, and inert resources that are not consumed by their use. This distinction foreshadows not only the thought of the early Christian Church and the Scholastic philosophers in the European Middle Ages, but also the work of economists in the twentieth and twenty-first century (see page 46 of this thesis). As Aristotle points out, Attic Greek uses a single word, *tokos*, to refer both to the literal offspring of animals and to the metaphorical offspring of monetary loans, a usage similar to the linguistic conventions of the other ancient cultures to practice interest: Sumerian uses the single word *mas* to refer to both calves and to interest; Egyptian uses *ms* for 'interest' and *msj* for 'to give birth'; and Latin uses a single term *foenus* for both interest and calves (M. Hudson 2000: 133, Homer and Sylla 1996: 20). Aristotle's argument is that although they share the same word, the characteristics of these two things are different and should not be treated the same. Later on in the section of the *Politics* quoted from above,

he makes a distinction between things obtained from the soil and "fruitless" or "barren" but useful things such as metal obtained by mining; and though Aristotle does not explicitly spell it out, the implication seems to be that it is unnatural to treat money, a barren metal, in the same way as living things that are capable of reproduction. And though Aristotle's focus on the use of metals solely for exchange does not quite hold up – after all, materials like grain that do reproduce could be used instead of metal money, and precious metals are not only used as a means of exchange but can also have uses such as jewellery, utensils, or tableware – the wider point that the commensurability of two objects in terms of exchange might not necessarily extend to every characteristic of those objects is a fundamental realisation, and remains central to the problem of financialisation to this day.

In Athens, the institution of titled property and the charging of interest on loans accompanied a period of growing trade and territorial expansion. Whilst the practice of charging interest on loans had been able to survive in ancient Mesopotamia because powerful rulers could peridocally enact clean slates, there was no similarly powerful authority in ancient Athens. Yet as is evident from Aristotle's distaste for it, the practice of charging interest on loans had persisted into the third century BC, right up to time of the Macedonian invasion that ended Greece's classical period. The historian Ian Morris estimates that during the period 800-300 BC the population was growing at a fairly consistent rate of about 0.4 percent per year (Morris 2004:

727), and in the absence of clean slates, aggregating consistent repayment of interest-bearing loans across a non-shrinking population implies an economically growing economy. And indeed the Greek economy does appear to have been growing: estimating living standards from physical remains, Morris estimates economic growth over the same period, from 800 to 300 BC, to have been between about 0.07 and 0.14 percent per year, comparable to the 0.2 percent annual growth of Holland's economy in the period from 1580 to 1820 AD that included the Dutch Golden Age (Morris 2004: 726). Part of this growth was due to trade increases across the Mediterranean (Morris 2004: 734), but perhaps most importantly the period of economic growth also coincided with territorial expansion westward: between 750 and 500 BC colonialism roughly doubled the area of arable land under Greek control, land consisting of a higher proportion of arable and receiving more reliable rainfall than that of Attica (Morris 2004: 733).

7.3 The Roman Republic

The history of Rome is similarly punctuated by these themes of interest, debt crises, and colonial expansion. The last king of Rome had been expelled in 509 BC and the Roman Republic established. According to Livy, already by 494 BC a "blaze of hatred" was rising among those who found themselves "enslaved and oppressed" by their indebtedness to their fellow citizens (Liv.

2.23). This marked the start of more than two centuries of civil strife, known as the Conflict of the Orders, the causes of which are described by the historian Appian in the first line of *The Civil Wars*: "The plebians and the Senate of Rome were often at strife with each other concerning the enactment of laws, the cancelling of debts, the division of lands, or the election of magistrates" (Appian *CW* 1.0, trans. Horace White).

These sources of conflict identified by Appian are intertwined: only members of the patrician order could become Senators, and patrician magistrates were unwilling to enforce the laws on interest, with the result that many members of the plebian order became indebted and lost their lands in default. In 494 BC the Senate refused to declare their policy with regard to the treatment of the indebted (Liv. 2.32), resulting in the First Plebian Seccession whereby the plebian order, to which most debtors belonged, withdrew from Rome to set up camp three miles outside the city (Liv. 2.33). To end the Seccession, the plebians were enticed back into Rome by the promise of their own magistrates to represent them (Liv. 2.33). However, this promise was almost immediately threatened: during a grain shortage caused by the plebians having left their fields uncultivated during the seccession, senators led by Marcius Corialanus argued that imported grain should be withheld from the plebians unless they gave up the rights they had won (Liv. 2.32). The plebians almost resorted to arms. Corialanus was put on trial, but fled into exile (Liv. 2.35).

This initial breakthrough for the plebians was gradually followed over the next two centuries by a series of further reforms. In 450 BC legal reforms, inspired by Solon's efforts in Athens, resulted in the Twelve Tables. Tacitus later writes that these were the first to introduce legal limits to the amount of interest that could be charged on loans, and that "the Twelve Tables prohibited any one from exacting more than ten percent, when, previously, the rate had depended on the caprice of the wealthy. Subsequently, by a bill brought in by the tribunes, interest was reduced to half that amount, and finally compound interest was wholly forbidden" adding that further laws had been required to prevent the ever more inventive ways that lenders had found to get around this prohibition (Tac. *Ann.* 6.16). Livy writes that the plebs very soon found themselves burdened once again by "an enormous load of debt, which they could have no hope of lightening except by placing their representatives in the highest offices" (Liv. 6.35).

In 368 BC, after nine years of political manouevring, the plebian tribunes finally forced through the first two laws of the *lex Licinia Sextia*, legislating that interest already paid on a sum must be counted towards payment of the principal, and setting an upper limit on the lands any individual could hold (Liv. 6.35). A new set of legislation, in either 313 or 326 BC,[2] the *lex Poetelia* was apparently required to outlaw the enslavement of debtors (Liv. 8.28, Varro 7.105). It also established a new kind of contract for loans,

[2]Livy dates the law to Gaius Poetilius Libo Visulus's third consulship, Varro to the year he was elected dictator; Varro 1958: 359.

the *mutuum*, specifically for objects that were quantified and consumed in use. The logic behind the *mutuum* was that the loan of a thing consumed by its use meant that the thing itself could obviously not be returned but that such a loan could only be repaid in kind; that is, the repayment would be of a specified equivalent. The very name *mutuum* apparently derived from the idea that the object being transferred was transferred absolutely: what had been mine (*meum*) now became yours (*teum*) (*Digesta* 12.1.2.2). The *mutuum* would later have an important influence for European thought, where much would rest upon the distinction between charging for a loss incurred during the use of a thing, and charging when no loss has occurred. Indeed, this distinction would form the basis for the very difference between the terms 'interest' and 'usury', for whilst the latin verb *intereo* means 'to be lost' and would refer to the price paid to compensate the lender for losses incurred as a result of a loan, the noun *usura* means 'use' and came to refer to the price paid merely for the use of some thing (Homer and Sylla 1996: 73, Graeber 2011: 290, Noonan 1957: 105-112). As the number of dispossessed grew, so too did the number of colonies: between 367 and 287 BC twenty-one Latin colonies and six Roman colonies were founded (Abbott 1911: 49). The details of the final struggles of the Conflict of the Orders are less clear since Livy's eleventh volume is not extant, but it again seems that the Senate refused demands for debt relief, provoking the Final Plebian Secession of 287 BC. The plebians were again enticed back to Rome, this time through enactment of the *lex Hortensa* legislating that laws passed by the plebian

tribunes would actually be enforced on all citizens, patrician and plebian alike (Eutropius 2.6f, Abbott 1911: 50-52).

The period from 287-133 BC, sometimes called the Sepremacy of the Nobilitas or of the New Nobility, was characterised by internal political stability and colonial expansion. The new oligarchic class, composed of both wealthy plebians and the aristocratic patricians, became increasingly involved with foreign wars (Abbott 1911: 64, 80-87), apparently initially as a measure of self protection against overseas threats, but gradually developing into a policy of conquest for territorial enlargement (Abbott 1911: 88). The greed of creditors was "held in check by numerous laws governing usury", laws that were ultimately applied to all of Rome's allies to prevent their evasion (Liv. 35.7). However, peasant proprietors fighting overseas had already long neglected their fields, and after the damage caused by Hannibal's occupation during the Second Punic War, by 201 BC much of the land of Italy was no longer cultivated. As long uncultivated land was converted from arable to pasture the demand for agricultural labour was greatly reduced; slave labour seized from conquered territories reduced wages further and bankrupted peasant proprietors who could not compete with large slave plantations both in Italy and in the newly acquired provinces (Abbott 1911: 77). Early on, the propertyless *proletarii* had been drawn to the colonies, but only one new colony is reported to have been established after 180 BC (Abbott 1911: 78).

Soon after the end of this period of colonial expansion, the Crisis of the

Roman Republic, beginning 134 BC, would lead ultimately to the end of the Republic. Tiberius Gracchus had secured election as plebian tribune in the previous year and immediately proposed the reenactment of the clause, slightly modified, of the *lex Licinia Sextia* from 368 BC limiting the amount of land an individual could hold, and proposed dividing land holdings in excess of this amount among poor citizens. His arguments were not as philosophic as Aristotle's had been, but pragmatic, highlighting the military advantages of citizens over slaves and recalling a particularly problematic slave rebellion in Sicily the previous year. Appian writes:

> it was supposed that the remaining land would soon be divided among the poor in small parcels. But there was not the smallest consideration shown for the law or the oaths. The few who seemed to pay some respect to them conveyed their lands to their relations fraudulently, but the greater part disregarded it altogether, till at last Tiberius Sempronius Gracchus, an illustrious man, eager for glory, a most powerful speaker, and for these reasons well known to all, delivered an eloquent discourse, while serving as tribune, concerning the Italian race, lamenting that a people so valiant in war, and related in blood to the Romans, were declining little by little into pauperism and paucity of numbers without any hope of remedy. He inveighed against the multitude of slaves as useless in war and never faithful to their masters, and

> adduced the recent calamity brought upon the masters by their slaves in Sicily, where the demands of agriculture had greatly increased the number of the latter; recalling also the war waged against them by the Romans, which was neither easy nor short, but long-protracted and full of vicissitudes and dangers (Appian *CW* 1.1.9).

Impeded by the veto of his colleague Octavius, Tiberius secured the removal of Octavius by a vote of the people, provoking a constitutional crisis. Appian (*CW*1.10) reports that there was "All kinds of wailing" by land-owners and money-lenders who had made loans secured on those lands, but despite their protests the law passed, though Tiberius himself was assassinated while seeking reelection (Appian *CW* 1.16). Censuses indicate that between 135 and 124 BC the number of citizens grew from 318,000 to 395,000, a large majority of whom would have gained their citizenship by becoming landowners under Tiberius's law. Elected tribune in 123 BC, Tiberius's brother Gaius sought to extend the citizenship rights of non-Roman Latins and other Italian Allies, as non-Romans did not hold the *ius commercii* rights of ownership that applied to full citizens. That legislation did not pass, and Gaius also met a violent death. The laws of 118 and 111 BC ended the policy of agrarian redistribution, and by 91 BC, after a final attempt at agrarian and citizenship reform had failed, the Republic's Italian population took up arms. The civil war from 91 to 88 BC, known as the Social War, ended with the passing of

legislation extending Roman citizenship to citizens of allied states (Appian *CW* 1, Abbott 95-102).

But the Crisis continued. Wars were fought in Anatolia, in Greece, in Armenia, and in Spain. Italy itself saw a number of civil wars and an uprising by as many as seventy thousand slaves broke out (Abbott 1911: 104-108). Reactionary reforms, especially those led by Sulla from around 82 BC, strengthened the power of the wealthy oligarchic families (Abbott 1911: 104-5, 108), and a number of legislative attempts to improve the condition of the poor in Rome, and throughout Italy, were prevented by the power of the oligarchs (Abbott 1911: 110). Cicero writes of this period that the problems of indebtedness had never been greater (*De Officiis* 2.84), and Sallust reports that numerous dispossessed plebian farmers were moving to the city and swelling the number of urban poor (*Bellum Catilinae* 37). In 63 BC, conspirators led by the politically frustrated Senator Cataline and supported by bankrupt aristocrats, poor freemen and former slaves, democratic reformers, discontented peasant proprietors, and a handful of disgraced former Senators, advanced on Rome, but did not make it as far as the city gates (Abbott 1911: 111, Sallust *Cat.* 37).

Military expansion continued, as did the influence of the oligarchs. So too did the practice of making loans at exorbitant rates of interest. At one point money-lenders and tax-gatherers in Rome successfully lobbied for Lucullus, the governor of the province of Asia who had checked their more exorbitant

demands, to be recalled to Rome (Abbott 1911: 118). Cicero, then governor of Cilicia, famously wrote in dismay to the Senator Marcus Junius Brutus who was charging people in the province interest at a rate of 48 percent, four times the maximum legal rate of the time (Abbott 1911: 123, Homer and Sylla 1996: 47). The uprising led by Boudica in Britain in 61 BC seems also partly to have been fuelled such practices, Dio Cassius writing that "Seneca, in the hope of receiving a good rate of interest, had lent to the islanders 40,000,000 sesterces that they had not requested, and had then all at once called in this loan and resorted to severe measures in exacting it" (*Roman History* 62.2, trans. Earnest Cary). The conquests of Caesar and Pompey extended Roman influence to the Euphrates in the east, to the Rhine in the north, and to Britain in the west, and in the south, except for Egypt and Mauretania, the entire Mediterranean coastline was under Roman control (Abbott 1911: 123). In 49 BC civil war broke out again, this time between the partisans of Caesar and those of Pompey; Pompey was killed in Egypt in 48 BC, Caesar in Rome four years later (Abbott 1911: 129-133).

7.4 The Roman Empire

Octavius, the nephew and adopted son of Julius Caesar, was the eventual victor of the civil wars that followed, and would become the first Roman emperor. In 29 BC he returned to Rome, used treasures taken from Egypt to

buy land for 120,000 former soldiers, and granted a general amnesty for the followers of his rivals (Abbott 1911: 266). In 27 BC the Senate inferred upon Octavian the honorific *Augustus* and made him the *imperium proconsulare* initially for ten years, later extended (Abbott 1911: 268-9, 271). As Augustus Caesar, he enacted tax reforms and reforms to increase the Roman population, and centralised control of the army, even in the provinces (Abbott 1911: 274, 285). Augustus's three immediate successors, Tiberius, Caligula, and Claudius, continued to strengthen the borders of the empire, but except for Britain, made no serious attempts to extend them (Abbott 1911: 284, 298). Under Nero, the fifth emperor, the treasury became depleted through extravagent spending, expensive foreign campaigns, and the great fire of 64 BC, and began debasing the coinage (Abbott 1911: 296). Nero's suicide in AD 68 was followed by a short civil war during which Glaba, Othos, Vitellius, and finally Vaspasian were all proclaimed emperor in quick succession.

Proclaimed emperor in 69 AD, Vaspasian was the soldier son of a tax collector and grandson of a debt collector (Abbott 1911: 305). According to his own estimates, reorganising the Empire's financial system and providing for its material needs would require the incredible sum of forty billion sesterces, a sum he raised partly through new taxes, but largely by removing tax exemptions for the wealthy and insisting on transparent accounts (Abbot 1901: 307-308). Rebellions across the empire in Pontus, Britain, Moesia, Judea, and among various German and Gallic tribes were put down in AD 70, and

the Roman territory in Britain extended north to Lincoln and Chester (Abbott 1911: 313-314). Titus, Vaspasian's son and successor, did not inherit his father's financial acuity and spent large sums on public entertainments during his short two year reign (Abbott 1911: 309-310), and though Domitian, Titus's brother, was a more financially conscientious emperor, he was also tyranical, autocratic, and paranoid of anyone who might challange him, and was ultimately killed by members of his own household in AD 96 (Abbott 1911: 312). During the two year reign of his successor, Nerva, several of Domitian's abuses of power were corrected, and the impoverished people of Italy were loaned money at a very low rate of interest, for the purchase of land (Abbott 1911: 317).

In AD 98 Trajan, Nerva's adopted son and governor of Upper Germany, succeeded to the throne unopposed (Abbott 1911: 317). Following raids from the north, he began a military campaign to subdue the Dacians, and in 107 the country became a province. Arabia was made a province in 106, and Mesopotamia and Armenia won from the Parthians in 114-5 (Abbot 1901: 324-325). This rapid expansion led the Roman Empire to its greatest ever territorial extent by Trajan's death in AD 117, but despite the expansions the widespread impoverishment of the poorest was a continuing problem (Abbott 1911: 325). His successor Hadrian, upon ascession to the throne, forgave tax debts to the value of 900 million sesterces, and put a stop to the expansion of the Empire, building a wall in Britain marking the Empire's northernmost

limit. The emperors Marcus Aurelius and Antoninus Pius who coreigned after him again found themselves fighting uprisings in the provinces (Abbott 1911: 324, 326), with the longer lived Marcus Aurelius increasingly debasing the coinage to cover expenditures (Abbott 1911: 326). Under Commodus inflation became rampant, and after his assassination by soldiers in 191 AD the army seems to get the taste for annointing and dispatching emperors: in the period from 180 to 285, characterised by civil wars, 25 out of 27 emperors or would be emperors met violent deaths. The Crisis, or Chaos, of the Third Century was the beginning of the end of the ancient world.

In his surveys of the history of the ancient world, Moses Finlay repeatedly concludes that all ancient revolutions have the same demand: to cancel the debts and redistribute the land (see Graeber 2011: 393). Contemporary observers such as Livy, Plutarch, and Tacitus are unanimous in describing interest-bearing loans as the main cause of the social unrest and societal collapse they witness (M. Hudson 2002: 29). Diodorus of Sicily, writing during the first century BC, approvingly describes how in eighth century Egypt the pharaoh Bakenranef had abolished debt bondage and cancelled debts on the basis that "the bodies of citizens should belong to the state, to the end that it might avail itself of the services which its citizens owed it, in times of both war and peace. For he felt that it would be absurd for a soldier, perhaps at the moment when he was setting forth to fight for his fatherland, to be haled to prison by his creditor for an unpaid loan, and that the greed of pri-

vate citizens should in this way endanger the safety of all" (Diodorus 1.79, trans. C. H. Oldfather). Indeed, by the end of antiquity, the Roman army had been largely recruited from the ranks of the dispossessed and foreign captives. Politicians including Tiberius Gracchus, Cato the Elder, and even Seneca repeatedly condemn usury as being worse than theft and even as bad as murder, their thoughts on the subject similarly guided by such pragmatic concerns as sustaining an army and preventing civil unrest, and by the military and social advantages that a population of peasant-proprietors affords over a population of dispossessed proletarians and slaves. The problem that precious metals do not reproduce at the pace with which debts – and soldiers wages – needed to be paid had been met partly by territorial expansion and then later by progressive debasements of the currency. By the short reign of Claudius Gothicus in 268-270 AD, silver coins had become so debased that they contained less than 0.02 percent silver (Michell 1947: 2).

7.5 Hebrew law and the early Christian Church

The ancient Hebrew approach to interest had borne a striking resemblance to that of the ancient Mesopotamians, with a jubilee year every forty-nine or fifty years[3] marking the forgiving of debts and return of lands. In this, the Hebrews seem to have been directly influenced by the Mesopotamians:

[3]Leviticus 25:8 suggests the jubilee coincides with the seventh sabbatical year, whilst 25:10-11 seems to suggest it follows it.

Leviticus 25, containing material perhaps as old as the late 7th century BC and relating events supposed to have happened several hundred years earlier (Grabbe 1993), uses the words *daror* and *misarim*, loanwords from the Akkadian *andurarum* and *misarum*, to refer to the freeing of indentured debtors and the forgiving of debts (Lemche 1979: 22). According to the principles repeatedly set out in Leviticus 25, during the Jubilee year the landless were to both return to their original land and to have that land returned to them; verse 16 clarifies that land itself cannot be sold and that only the remaining harvests before the next Jubilee can be sold, and verse 23 explicitly states that land must not be sold permanently; that is, whilst the resources that flow from a stock of land over a certain period of time could be bought and sold, the stock itself could not. With regards to charging interest on loans, Leviticus 25:37 collapses the ancient Mesopotamian's distinction between agricultural and commercial loans by forbidding both the lending of money and of food at interest. The Old Testament prohibition on charging interest is also stated in Exodus 22:25 and Deuteronomy 23:19-20[4], this last verse explicitly stating that whilst 'brothers' may not be charged interest, interest may be charged to 'foreigners' (Hebrew: *nokri*). The prohibition on lending at interest is again reitereated by the Psalms 15:5, Proverbs 28:8, and Ezekiel 18:8, 18:13, 18:17, and 22:12, with Ezekiel condemning those who take interest to death.

In the Gospels even expecting to receive back the amount that was lent is

[4]Numbered following the Christian convention.

criticised as being contrary to Christian charity, both in Matthew 5:42 and particularly in Luke 6:34-35[5]. The Roman Emperor Constantine – Constantine the Great – decreed tolerance for Christianity in the Edict of Milan in 313 and converted to Christianity before he died in 337. The Early Christian Fathers, trying to avoid the problems of indebtedness that had plagued Rome during the chaos of the third century, now began to develop the Judeo-Christian doctrines against usury to establish a moral as well as pragmatic approach to legislating against interest-bearing loans (Graeber 2011: 283, Holman 2001:112-26, Jones 2004: 25-30). Convened and presided over by Constantine himself, the First Council of Nicea in 325 cited Psalm 15 and reitereated the 314 decision of the Council of Arles to ban the clergy from charging interest on loans, which itself may have been a reiteration of an earlier decision of the Council of Elvira in 305 or 306 (Homer and Sylla 1996: 70, Vermeersch 1912: 235). The ban was extended to the laity by the First Council of Carthage in 345 (Vermeersch 1912: 235) even before the Edict of Thessalonica in 380 made Nicene Christianity the state religion of the Roman Empire. The early Christian Fathers, including Apollonius, Clement of Alexandria, Tertullian, Cyprian, Gregory Nazianzen, Gregory of Nyssa, Augustine, and John Chrysostom all condemn interest, their sermons illustrating that practical concerns as well as Bibilical interpretation played a role in these decisions (Vermeersch 1912, Holman 2001). In a sermon of AD

[5]The only two uses in the Gospels of the word *tokos* are as Matthew 25:27 and Luke 19:23 give synoptic accounts of the parable of the talents, passages not principally concerned with financial ethics; see also Jones 2004: 25.

365 Saint Basil of Caesarea reminds Christians of the Biblical injuntion not to refuse those in need, before describing the negative outcome for a man who must borrow at interest, describing the debtor as the "wretched victim" of a "merciless" creditor who "binds him with a written security, adds loss of liberty to the trouble of his pressing poverty, and is off. The man who has made himself responsible for interest that he cannot pay has accepted voluntary slavery for life" (quoted in Graeber 2011: 283-4).

Charging interest was considered taking possession of something without having the right to it, irrespective of the fact that the debtor had contracted to pay it. In his *De Tobia* pronounced in AD 380, Saint Ambrose relates stories of debtors forced to sell their children and committing suicide from shame, and equates usury with violent robbery and murder (*De Tobia* 15.51, *De Officiis* 2.25.9; see also Graeber 2011: 284). Carefully examining every Biblical reference to moneylending, Ambrose particularly notes the exemption from a complete ban on charging interest indicated by Deuteronomy 23:20, the verse explicitly permitting loans to 'foreigners'. Though Saint Jerome argued that the later books, particularly Psalm 15, Ezekiel, and the New Testament had made all men brothers, Saint Ambrose instead interpreted the verse in light of the conflicts that the ancient Hebrews had had with their neighbours. If charging interest is equivalent to fighting only without a sword, Saint Ambrose reasons, then it would not be a crime to charge interest to those "whom it would not be a crime to kill" (Graeber 2011:

285). Though his interpretation now seems somewhat doubtful, not least since throughout the Old Testament the distinction is made between resident foreigners (Hebrew: *ger*) and nonresident *nokri* who have come "from distant lands" (Deuteronomy 29:22), his interpretation became known as the 'Exception of Saint Ambrose' and would sustain centuries of debate, as well as actual violence, about whether Jews, Christians, and Saracens were considered sufficiently foreign to allow lending between them or not (Noonan 1957: 101-102). Only much later[6] is an alternative explanation put forward: that Hebrew law allows interest to be charged to *nokri* because these nonresident foreigners have come to Israel to trade. Upon this interpretation, the Hebrew distinction is again reminiscent of the Mesopotamian distinction between agrarian loans that are periodically forgiven and commercial loans that are not; but such an interpretation appears not to have occurred to the thinkers of the early Church.

In 443, in a document that the jurist and philosopher John Noonan describes as "the single most important document of the early Church on usury", Pope Leo the Great reiterated the ban on clerics but went further, declaring the charging of interest to be intrinsically unjust and that laymen who charged interest to be guilty of "shameful sin" (Noonan 1957: 15). Also likely dating to the fifth century, the statement known as *Ejiciens* is probably the clearest indication of the early Church's reasoning behind this prohibition of interest-bearing loans, arguing that:

[6]Matthew Henry's 1706 *Complete Commentary on the Bible* is the earliest I have found.

> Of all merchants, the most cursed is the usurer, for he sells a good given by God, not acquired as a merchant acquires his goods from men; and after the usury he reseeks his own good, taking both his own good and the good of the other. A merchant, however, does not reseek the good he has sold. One will object: Is not he who rents a field to receive the fruits or a house to get an income similar to him who lends his money at usury? Certainly not. First, because money is only meant to be used in purchasing. Secondly, because one having a field by farming receives fruit from it; one having a house has the use of inhabiting it. Therefore, he who rents a field or house is seen to give what is his own use and to receive money, and in a certain manner it seems as if he exchanged gain for gain. But from money which is stored up you take no use. Thirdly, a field or a house deteriorates in use. Money, however, when it is lent, is neither diminished nor deteriorated (quoted in Noonan 1957: 38-39).

The first point of *Ejiciens*, then, echoes Aristotle's assertion that money is to be used for exchange, from which follows the second point that loaning money does not incur a cost on the lender in the way that lending a house or a field would. And intriguingly, the third point echoes the logic of the Roman *mutuum* contract set out in the *lex Poetelia* of 313 (or 326) BC in making a distinction between goods that can be returned having merely

suffered some deterioration since they were borrowed, and goods that are completely consumed by their use and so can only be returned in kind. An object of the first kind – what economists might call a 'fund-service' – is not consumed by its use but might be worn out a little, by which reasoning it is entirely legitimate to charge a small fee for borrowing it to cover the costs of maintenance or eventual replacement. But an object that is completely consumed – some quantity of 'resource flow' – can only be returned in kind to the exact value of its equivalence, in which case no excuse for charging such a fee can be made.

The view of the early Church, then, was that titles to property obtained through charges merely for use were usurious: they were illegitimate because no cost had been incurred by the lender, no consideration given for the payment they received. In 789 the Council of Aix reiterated the earlier decision of Carthage that the laity, too, were prohibited from charging interest on loans, and in 806 the first Holy Roly Emperor, Charlemagne, criminalised usury; for good measure, in 850 all lay usurers were excommunicated by the Synod of Pavia (Homer and Sylla 1996: 70). And so for the next thousand years debates would focus on trying to determine whether a particular contract established a legitimate right to an interest charge; if it did not then it was therefore usurious and tantamount to theft.

7.6 Medieval Europe

Though keen to enforce Biblical prohibitions on usury, during the first millenium the Church had apparently not greatly objected to debt peonage gradually being replaced by serfdom and vassalage across Western Christendom (Graeber 2011: 287). But by the start of the second millenium Europe was emerging from its prolonged slump, and learning and commerce began to revive (Homer and Sylla 1996: 70). Already by the tenth or eleventh century nonjewish professional money lenders like the Cahors from France (Graeber 2011: 289) and the Lombards of Northern Italy had spread throughout Europe (Homer and Sylla 1996: 71, Graeber 2011: 289). For the growing number of lenders and traders, a clarification of the line between legitimate contracts and illegitimate usury had become an urgent legal and religious concern.

Coinciding with the expansion of commerce, the gradual revival of Roman law gave the Scholastic thinkers of twelfth century Europe a far wider range of legal arguments than their predecessors had had for centuries (Stein 1999:43-44). In particular, the logic of the *mutuum* contract, established in the *lex Poetelia* and echoed in *Ejiciens*, was that interest could be charged as compensation for a loss, but to charge merely for the use of a thing was usury. Therefore, a contract charging interest to cover costs was legitimate, but contracting to receive a fee for usury was not, and since contracts for the payment of fees were additional and separate from the *mutuum* contract

detailing the loan of the object itself, such additional contracts became known as 'extrinsic titles'.

And so the scholastic debates came to focus on trying to distinguish legitimate extrinsic property titles from those acquired usuriously. Central to this was the question of whether a loss had in fact been incurred by a lender when making a loan, but working that out was far from easy. That profit could be made from the rent of a durable good (*locatio*) and from investments in a partnership where losses as well as gains would be shared (*societas*) seems to have been uncontroversial (Noonan 1957: 32, 133-134, 1965: 220n22, Melitz 1971:474). But pretty much every other kind of property title seems to have been suspect, as all could be used by lenders to disguise usurious charges. Early on, Pope Alexander III (d.1181) had set out the principle of *venditio sub dubio*, that charging a higher price for future sales in circumstances of doubt to allow for inflation, for example, was considered a legitimate title; but already by the papacy of Pope Urban III (1185-1187) it needed to be clarified that credit sales at excessively high prices were still to be considered usurious (Noonan 1957: 90-91). Similarly, around 1200, there began an investigation into foreign exchange, particularly whether it was usurious for a bank to buy foreign currency to be delivered at a future date in that foreign country, a question so difficult that it took four hundred years to finally resolve, in favour of the bankers (Noonan 1965: 220, 1957: 182-190, 311-335; see also de Roover 1967). In the early thirteenth century, the terms *lucrum*

cessans and *damnum emergens* referring respectively to 'foregone profits' and to 'costs arising' from a contract were discussed, with later writers considering both to be legitimate extrinsic titles (Graeber 2011: 440). A charge for late repayment also seems to have become acceptable around this time, and by around 1220 the word '*interesse*' becomes standardly used to simply mean a 'fine for late payment' (Homer and Sylla 1996: 73).

With the translation of Aristotle from the Arabic, in the mid-thirteenth century Saint Thomas Aquinas (1225-1274) attempted to reconcile the Aristotelian arguments with Biblical doctrine. Thomas endorsed earlier decisions to permit fines on late payment (Homer and Sylla 1996: 74), and also allowed the *census* contract, an important form of agricultural credit and municipal finance in which a resource stock such as land was loaned in return for a share of the flows harvested from it (Noonan 1965: 220n23, 221). Like the logic of the *mutuum* and of *Ejiciens*, Thomas also argued that the distinguishing feature of usurious titles were that they represented 'two recompenses' for a single good, writing:

> I answer that to receive usury for money loaned [*mutuata*] is in itself unjust, because that is sold which does not exist, by which clearly an inequality is constituted which is contrary to justice. For the evidence of which it must be known that there are certain things the use of which is the consumption of those things; as we consume wine by using it for drinking or we consume wheat

> by using it for food. Whence in such things the use of a thing ought not to be computed separately from the thing itself; but to whomever is granted the use from that fact itself is granted the thing; and on account of this in such things through the loan [*mutuum*] ownership is transferred. If anyone therefore wishes to sell separately the wine, and again wishes to sell the use of the wine, he would sell the same thing twice, or he would sell that which does not exist; whence clearly he would sin by injustice. And by a similar reason he commits injustice who loans [*mutuat*] wine or wheat seeking to be given two recompenses; one indeed the restitution of an equal amount of the thing, the other, on the other hand, the price of the use which is called usury (St Thomas Aquinas, *Summa theologiae* 2-2, q. 78, trans. Noonan).

But a problem remained, since making a loan of money that could otherwise have been profitably invested in another venture represented a loss of profit to the lender. Thomas is clear that such losses do not count as costs (*Malo* 13.4 and 14; *Summa* 2-2.78.2 ad. 1), and most scholastic thinkers before around 1450 are similarly agreed that any extrinsic titles requiring the debtor to recompense the creditor for such losses are usurious (Noonan 1965: 221). After 1450, however, the theologians typically permit such titles if the lender's loss was likely, and by 1600 it would be conceded that the prevalence of money markets effectively now meant that making an interest-free

loan to one person would mean that a lender always missed out on making a profit elsewhere (Noonan 1965: 221, 1957: 249-268). With the increasing prevalence of financial markets, the assumption of *Ejiciens* as well as Thomas that unloaned money was simply hoarded and kept idle was simply no longer true; all interest-free loans would now have an opportunity cost for the lender.

Moreover, as in ancient Rome, investors used ever more inventive means to adhere to the letter of the usury prohibition whilst nevertheless earning interest on loans. In 1515 John Eck, funded by the banking family the Fuggers of Augsburg, published his *Tractatus de contractu quique de centum* in which he defended a five percent rate for genuine business purposes, and popularised the triple contract or *contract trinus*, consisting of a contract of investment, a contract of profit, and a contract of insurance, providing a means by which to avoid the usury prohibition (Burke 2009: 14). Pope Pius V issued a bull in 1569 to curb usurious abuse of the *census* contracts whose proper use had earlier been defended by Thomas and others, and in 1571 he directs an encyclical letter against the use of foreign exchange to hide usury (Burke 2009: 14). In 1586 Pope Sixtus V directs the bull *Detsetabilia avaritia* against the usurious abuses of the *contract trinus*. For though the Catholic church had gradually permitted interest to be charged on rental agreements, commercial investments, credit sales, international commercial banking, and some forms of agricultural credit and municipal finance, their position throughout had

been to consistently condemn usury absolutely. This absolute condemnation rested on both Old and New Testaments, three Ecumenical councils, and the edicts of a half dozen popes (Noonan 1957: 222).

It would be another two centuries before the papacy finally gave up its attempts to discern legimitate property titles from usurious claims. As Father John Cronin explains: "Our moral theology texts were, in general, hopelessly out of date in applying moral principles to economic life. Apparently few moralists knew enough about economic facts to work out a realistic and complete solution" (quoted in Noonan 1957: 336). In 1745, Pope Benedict XIV's encyclical *Vix pervenit* would reassert that usury could not be condoned, but conceded, vaguely, that "legitimate reasons arise to demand something over and above the amount due on the [*mutuum*] contract" as long as those reasons were"not at all intrinsic to the contract", a statement effectively marking the end of the Catholic Church's attempts to understand usury, much less to control it. But arguably even the attitude towards usury adopted by the early Protestant Reformers, not bound by earlier decisions of Rome after the schism of the mid-sixteenth century, had been merely the acquiescence of an ecclesiastical leadership whose authority had already been significantly undermined by events beyond their control (J. Rubin 2011). Indeed, although John Calvin had enumerated seven instances where charging interest upon loans would remain a sin, this went widely unenforced (Visser and Macintosh 1998: 179).

In Holland as early as the tenth century, long before the Reformation in the mid-sixteenth ended the power of the Catholic Church there, most peasants had been freeholders of the land they had reclaimed, and so were already largely free from the kinds of constraints imposed by the Church elsewhere. By the end of the fourteenth century capital markets included trade by an increasing number of towns and villages, who by the beginning of the sixteenth century were offering long-term loans at a rate of about six percent (Van Bavel et al. 2012). The lack of a nobility similarly provided the circumstances for the establishment of a commodity market, and by 1500 around 90 percent of Holland's workforce was engaged in producing goods for market (Van Bavel et al. 2012). Fed by grain imported from northern France and the Baltics, and fuelled by commercially exploited domestic peat, the 'Dutch Golden Age' of trade, industry, colonisation, and economic growth lasted until the mid-seventeenth century, its decline coinciding with a decrease in the availability of peat and the rise of foreign competitors (Zeeuw 1978). Britain's rise would initally follow the same pattern but fuelled by coal which, unlike Dutch peat, would remain available in abundant quantities for centuries.

7.7 England from the Compromise to the Black Death

The incremental reemergence of titled property in England was much more by accident than design, and began long before the events of the English Reformation. A succession dispute in the twelfth century had led to eighteen years of civil conflict, ending in an agreement known as the Compromise of 1153 which implemented two key measures. The first resolved the succession question by allowing the current king, Stephen, to remain on the throne for his lifetime but stopped the succession of his sons, instead of which Henry II, the grandson of the previous king, Henry I, would be crowned (R. C. Palmer 21–1985: 8). The second measure applied a similar logic to the land dispossessions that had taken place during the conflict: current tenants would retain their land until their death, upon which the ancestor of whomever had been tenant at the start of the war in 1135 would inherit it (R. C. Palmer 21–1985: 9). This was the first categorical intervention of an English king into the relationship between lord and tenant (R. C. Palmer 21–1985: 48), and was followed by the Assizes of Clarendon in 1166 and of Northampton in around 1176 which ensured that the tenures were being transferred correctly, as well as by the issuance by the king of writs of enforcement, which would be secured by tenants to allow them to prosecute for the return of their tenancy (R. C. Palmer 21–1985: 11). The prosecution of these writs solidified the

jurisdiction of the royal court to intervene in seignorial justice, centralising the administration of justice, and sytematising what had formerly been more flexible customary standards into a more rigid common law for all of England (R. C. Palmer 21–1985: 1, 48, Biancalana 1988: 433-8, 493).

The intention behind the writs had not been to create property titles, merely to reestablish peacetime tenancies. Indeed, the reforms were essentially feudal in intent as they restored the relationship between lord and tenant, legislating for the provision of what had been the customary maintenance to a tenant's survivors, such as their widow or heir, a provision that had been a central aspect of the feudal relationship (R. C. Palmer 21–1985: 4-5). But the writing of royal writs as a means of establishing title to a tenancy soon also became commonly applied not only to villein land that was attached to a feudal lord, but also to freehold land held by tenants who had long enjoyed the direct protection of the royal court. Already by the 1160s, the establishment of a professional administration for the writing of writs had reduced the cost of acquiring a writ for the defence of a freehold tenure to one twentieth of what it had cost before (Campbell 2009: 89). By around 1200 these writs became used as proof of title, with 'writs of entry' being issued where one person claimed that another had no right of possession. This subtle shift is another one of those seemingly tiny variations, another tiny shift in the evolution of ownership away from feudal norms: for it was now possible for one tenant to prosecute another for the right to a tenancy, with the relevant lord

having no influence in the matter at all (R. C. Palmer 21–1985: 47). A short lived peace treaty between king John and rebellious barons known as the Magna Carta of 1215 may be more widely celebrated, but this nuanced shift away from a writ representing a title to a feudal relationship and towards it representing a title to use some land has perhaps had far greater historical consequences.

The creation of titles in land was followed by an increase in trade in land and increased credit. Historian M. T. Clanchy estimates that during the thirteenth century the number of village charters recording transfers of small pieces of freehold land to be in the hundreds of thousands or even millions (in Briggs 2009: 113), and as early as 1208-9 the pipe rolls of the bishops of Winchester record that villein land was also sold, a practice documented more widely by the 1240s (Campbell 2009: 91). Overseas trade increased the amount of silver coin in circulation at least eightfold in the period 1180-1290, making cash loans more accessible (M. Allen 2001, also in Campbell 2009: 93). Some of these loans were investment loans, charged at around ten or twelve percent annually, to fund pasture extension and improvements as well as buildings and vehicles, in an English economy increasingly exporting wool and hides, and tin and lead (Campbell 2009: 93, 80). By the end of the thirteenth century there is evidence of a large increase in inequality and poverty among the peasantry (Bekar and Reed 2013: 2), and though mortgages and repossessions are relatively rare prior to the mid-fourteenth century (Briggs

2009: 11, 121-123) there are contracts more similar to the vifgage or the Roman *census* contracts in which though the debtor was explicitly not at risk of losing their land, a creditor could seize the harvests from the land during any period of default (Briggs 2018: 19).

More common appear to be distress sales (Briggs 2009: 115-116, 119), with charters of sale sometimes stating that a particular sale was motivated by the need to raise funds in order to be "acquitted in the Jewry" (Briggs 2009: 119). England's Jews had enjoyed the Crown's protection, and by the thirteenth century had become specialised in moneylending, enjoying a near monopoly. Robert Stacey estimates that during the 1240s, a period for which detailed records survive, English Jews were owed between £76,500 and £79,000, almost a fifth of the total value of the all the coins in circulation (in Campbell 2009: 94). Stacey writes that "Nowhere else in northern Europe was there a Jewish community with so much wealth per capita, or one so completely dependent upon moneylending, as were the Jews of England in the century or so prior to 1275" (quoted in Campbell 2009: 94). In 1275 the Statute of the Jewry would later state that the king, though"he and his ancestors have received much benefit from the Jewish people in all times past", had been moved to outlaw usury and to oblige Jews to identify themselves by wearing a yellow badge as a result of having seen "that divers evils and the disinheriting of good men of his land have happened by the usuries which the Jews have made in time past, and that divers sins have followed thereupon".

During the period 1180 to 1220 commodity prices had doubled – and prices would continue to increase until the 1320s – and over the long thirteenth century land prices also rose (Campbell 2009: 89). Increasing commodity prices, increases in the rural population, and probably also increasing land fragmentation due to inheritance practices and distress sales drove the free peasantry into supplementing their subsistence activities with wage employment (Bekar and Reed 2013, Campbell 2005: 50-1). Whilst the Domesday Book of 1086 indicates that the vast majority of free peasant households obtained income above subsistence level from working their own holdings, by the time of the Hundred Rolls survey of 1279 most free peasants were only able to achieve subsistence levels of income by supplementing their harvests with waged employment (Dyer 2002: 186, Bekar and Reed 2013: 2). Much of the freehold land recorded in the Hundred Rolls was now held by gentry, clerics, tradesmen, and craftsmen, who presumably did not work the land themselves but leased it to peasants (Campbell 2009: 89-90).

The period of agricultural expansion from 1220, and especially after 1270, often included the enclosure of former common pasture and particularly woodland previously used for timber and fuel, and provoked a series of disturbances and even riots by an anti-enclosure movement. Though often conflated, land enclosures are of two broad kinds depending on whether it is common land or open fields that is enclosed; enclosures of open fields, which would become increasingly enacted after 1604, would often be initiated by farmers them-

selves who wished to exchange strips of scattered land, called selions, into more consolidated packages. These thirteenth century enclosures, however, seem to have been largely enclosures of common lands and much more likely to cause conflict, as people were denied access to resources to which they had previously had a customary right (Dyer 2006).

The 1283 Statute of Acton Burnell (11 Edw. I) and 1285 Statute of the Merchants (13 Edw. I) made it easier for commercial lenders, even Christians, to seize goods, rents, profits, and land from a defaulting debtor, who could also be imprisoned (Campbell 2009: 94). In the period before 1334, about 20 percent of debts registered under these statutes were defaulted (McNall 2002), a rate that seems to have remained consistent in London and in Coventry into the thirteenth and fourteenth centuries (Nightingale 2004). During the period 1284-1289, the average debt recorded by the statute certificates was £17, though throughout a wide value of debts were recorded by a variety of debtors that "included townsmen and countrymen, clergy as well as laymen, knights, minor landowners, merchants, craftsmen, and peasants" (Nightingale 2004: 10). Following the Expulsion of the Jews in 1290, non-Jewish lenders, particularly Italians, became more involved in moneylending and, unlike the Jews, had more interest in foreclosing on defaulters (Campbell 2009). Claims pursuing defaulters under the statutes steadily increased: the 407 statute certificates for 1301 are worth £8,834, whilst the 864 for 1309 are worth £29,439, more than trebling in total value in less than a decade

(Nightingale 2004: 16).

Already by around 1300, servile work accounted for only about eight percent of seignorial production, whilst wage labour accounted for more than 80 percent (Campbell 2009: 84). Labour was abundant and wages low, with Gregory Clark calculating that "at the opening of the fourteenth century they were lower than at any other time between 1209 and 1869" (Clark 2007 in Campbell 2009: 86). In a detailed study, David Stone estimates that fourteenth century wage labour was far more productive than servile labour and he suggests that the managers of estates were well aware of the fact (Stone 1997). In any case, since about half of the tenants in England were freeholders they could not be compelled to work by a lord; they could, however, be hired for wages (Campbell 2005: 26-36). In one study, of the manor of Halesowen, Zvi Razi finds that in the period 1270-1400 the vast majority of the wage labour to the manor was supplied by the children of the manor's tenants (Razi 1980).

The period from the 1290s to the mid-fourteenth century is characterised by increasing food scarcity, distress sales, and debt foreclosures (Schofield 1997). Several studies of East Anglia in the 1290s document the effects of bad harvests and an increase in taxation partly due to declining national income, and how this led, in a number of East Anglian manors, to a withdrawal of credit and an increase in distress sales of customary titles (W. Hudson 1921, Campbell 1984, 2009: 105, Schofield 1997). A similar pattern is also observed

in freehold sales (Davies and Kissock 2004: 215–30, Campbell 2009: 92), making East Anglia the most active villein and freehold market in England: during this period, more land there was sold than was inherited (Campbell 2009: 91). The English agricultural crisis of 1315-22, including the Great Famine of 1315-17, increased distress sales nationwide (Davies and Kissock 2004), but by the 1330s London's economic recovery was stimulating growth also in its neighbouring counties and the agrarian economy was beginning to recover (Nightingale 2004: 28-29).

The Black Death outbreaks of 1348, 1361, 1369, and 1375 killed around half of the English population (Dyer 2002: 271-2). As early as 1349 restrictions were put in place fixing wages at pre-plague levels, criminalising refusal to work and the breaking of contracts (Dyer 2002: 282). Interest rates also fell by about half, to around five or six percent: since the population had halved, the amount of coin available per person had doubled (Clark 1988, S. R. Epstein 2002: 61–2, Campbell 2009: 38). Some analyses place the Black Death at the beginning of the end of feudalism (particularly still R. C. Allen 2009: 21, citing his 1992: 37-77), but in light of these more recent analyses it now seems that the Black Death actually had the effect of temporarily reversing serfdom's decline, a decline that was already well under way before the population collapsed. Indeed, as Campbell points out, labour had in fact been subject to fewer restrictions in the century prior to the Black Death than it would be in the century that followed (Campbell 2009: 98).

7.8 England after the Black Death

During the mid-fifteenth century the economy stops shrinking and the population begins to grow again (Broadberry et al. 2015: 403). In the towns on London's periphery this is accompanied by an increase in mortgages even on customary land in places like East Sussex (Briggs 2018: 20). In Havering in Essex, one of around 32 market towns within twenty miles of London increasingly selling commodities to and obtaining credit from the city, there is a consolidation of larger landholdings and larger business ventures such as brewing; since women have less access to credit and cannot found companies, small scale female owned enterprises in industries such as brewing soon become outcompeted by larger male owned businesses (McIntosh 1988: 559, 564-566, Bennett 1996). Though laws against usury in 1487 and 1495 support the Church's jurisdiction in the matter (McIntosh 1988: 566), even in the canon courts cases against usury are rare and typically only prosecuted against individuals charging interest on fairly small sums of the kind that would only really be borrowed by the distressed poor (Helmolz 1986: 368). Moreover, the canon courts are even less equipped than the Church in Rome to determine the difference between usury and interest; at one hearing in Chichester in 1508, the question of whether a silver spoon given by one Richard Sawton to one Thomas Fowler who had previously loaned him 8 shillings implied usurious intent is never resolved, since the hearing is postponed by the judge "because it was arduous" and apparently never recon-

vened (Helmolz 1986: 373).

Sixteenth century England is dominated by the Reformation and its aftermath. In 1534 the Act of Supremacy enacted that Henry VIII "shall be taken, accepted, and reputed the only supreme head in earth of the Church of England" (26 Hen. VIII c. 1). Breaking from the authority of the Catholic church, over the next decades the parliaments of the Tudor monarchs would pass much legislation relating to titles to interest and to land acquired by creditors, almost all in defence of their legitimacy. Henry VIII's Parliament of 1545 enacted An Act Against Usurie (37 Hen. VIII, c. 9). Revoked during the Regency of Henry's son, Edward VI (5-6 Edw. VI, c. 20) but revived under Elizabeth I in 1571 (13 Eliz. c. 8), the act began by noting that previous usury laws had "been of so little force and effect, that by reason thereof little or no punishment hath ensued to the offenders ... but rather has encouraged them". The act removed the ambiguity that had plagued previous temporal as well as religious law by simply making the charging of interest above 10 percent an offence against the common law. Though technically not legalising the charging of interest at rates below ten percent, it soon became clear that the full force of the law would not be applied to those charging ten percent or less (Helmolz 1986: 379-380, Clay 1984a: 150-1, Clay 1984b: 232-33). The break from the Catholic church had, then, also allowed a break from medieval canon law. Though legislation by northern Swiss Protestants and the Habsburg Netherlands a few years earlier had permitted interest up

to a limit on commercial loans, the English law of 1545 is the first post-schism legislation to make no distinction whatsoever between commercial loans and consumption loans, effectively setting the same maximum limit for both (Helmolz 1986: 379). There was no longer any preoccupation with enquiring into such arduous and complicated matters as to the intent behind various extrinsic titles or whether Jew and Christian were 'foreigners'. Illegitimate usury could now be distinguished from legimitate interest titles simply by calculating the rate at which the loan or mortgage was charged.

Credit, already dominating commercial life in the mid-sixteenth century, became increasingly common in other spheres (Hoppit 1990, Muldrew 1998). The countryside saw the rise of professional usurers, and even poorer people not only borrowed but also began lending small sums at interest, as a means of making a living (McIntosh 1988: 568). From the 1560s onwards in towns like Havering on the outskirts of London, farms of three hundred acres or more drew on abundant cheap labour to specialise in grain and animal fattening (McIntosh 1988: 567), whilst self-styled 'urban yeomen' invested in commercial premises, lent sums in the hundreds of pounds, and provided mortgages including to gentry and nobles (McIntosh 1988: 569). Surveying personal correspondence, Tawney provides a picture of some of the debts owed by English nobles during the last two decades of the sixteenth century:

> The Duke of Norfolk owes £6,000 to £7,000; the Earl of Hunt-

ingdon £20,000, the Earl of Essex between £22,000 and £23,000, Viscount Bindon £4,000, the Earl of Leicester (it is reported) about £59,000, Sir Francis Willoughby (who had spent £80,000 in building Wollaton House) £21,000, Sir Percival Willoughby £8,000, Sir Philip Sydney over £6,000, Lord Sandys £3,100, Sir H. Parke £4,600 ... The Earl of Sussex is heavily in debt, though for an uncertain sum; so is Lord Thomas Howard; so is the Earl of Rutland. The Earl of Shrewsbury moves heaven and earth to borrow £3,000. Lord Vaux of Harrowden has been forced to pawn his parliament robes 'to a citizen where I have offered large interest', and subscribes himself 'the unfortunate Peer of Parliament for poverty that ever was'. The Earl of Southampton has surrendered his estates to his Creditors and 'scarce knows what course to take to live'. Lord Scrope cannot raise even £300, and is obliged to beg the loan of it from Cecil. Lord Lincoln has to hurry off a Servant to borrow £230 from a Tradesman 'this very day, for otherwise he cannot have it'. The Earl of Cumberland, on receiving a letter of Privy Seal requiring him to contribute to a loan, begs an advance from a London Merchant and explains that he can hardly raise twenty pounds. Lady Burgh and her five children face the world with a capital of £400 ... (Tawney 1925: 17-19).

In 1543, two years before his usury law, Henry VIII's parliament had passed an act allowing the imprisonment of debtors and the distribution of their estate and effects among their creditors (34 and 35 Henry VIII c4). The laws were clearly having an effect on the nobility, to the benefit of the growing number of merchants. During Elizabeth I's first parliament in 1559 her closest advisor, Sir William Cecil, had proposed limiting the land which merchants might buy to the value of £50 a year unless they were Aldermen or Sheriffs of London, a proposal never implemented (Tawney 1925: 22). The balance of wealth and of power was shifting. Endebted nobles sought ways to protect their estates from creditors, initially placing entailments on land titles to enforce primogeniture, and when this was restricted by the courts in 1614 'strict settlement' trusts would be developed with similar intent (English and Saville 1984, D. W. Allen 2011: 65). But poorer landowners did not have much access to such instruments, and even the richer ones were not entirely immune to dispossession by their creditors. Like Tawney, the economist Maurice Dobb has long been clear on the important role that legitimisation of interest-bearing loans and the acquisition of land through dispossession of defaulters played in the decline of traditional land holdings and the emergence of a commercial middle class. He writes : "When we examine the actual changes that were occurring in fifteenth- and sixteenth-century England, it is evident that economic distress at various periods both of large feudal landowners and of certain sections of smaller ones, placing them in the position of distress-sellers and involving them in mortgage and

debt, must have played a major role in facilitating easy purchase of land by the parvenu bourgeoisie" (Dobb 1947: 181).

The financial institutions of England were now increasingly well developed, closer to those of ancient Rome than at any time in the previous millennium (Temin 2004, Bayly 2003: 40). Whilst some landlords and yeomen prospered, some of the smaller landowners, and most labourers and cottagers, became increasingly worse off (Wrightson 1982: 130n; Clay 1984a 67n). William Harrison, rector of the Essex parish of Radwater and author of 1577's *The Description of England*, describes the increase in chimneys, improved bedding, and metal tableware as improvements seen over his lifetime, but also picks out three "very grievous" developments as the increase in rents, the oppression of copyholders by their landlords who force them to pay fines or forfeit their holdings, and the charging of interest upon loans (in Wrightson 1982: 129). Just as in ancient times, there were a growing number of land consolidations, and a growing number of landless proletarians. In 1607 the Midland Revolt, the deadliest of a series of peasant uprisings, broke out (Hardiman 1996: 114). Around that time William Shakespeare, a native of one of the three counties hardest hit by the Revolt, writes his *Corialanus* in which he has a Roman citizen complain that the ruling classes

> suffer us to famish, and their store-houses
> crammed with grain; make edicts for usury, to
> support usurers; repeal daily any wholesome act

> established against the rich, and provide more piercing statutes daily, to chain up and restrain the poor (Act I Scene I).

In the 1550s, the territory claimed by the English Crown was the smallest it had been for centuries, and by the end of the decade even Calais would be lost (Jacques 2007: 184). In Ireland, only a small area around Dublin known as The Pale was even nominally under English rule when in 1556 Mary I began a policy of recolonisation, a policy continued by Elizabeth I and James I until by 1603 all of Ireland was claimed by the English Crown (Ellis 2014). Elizabeth I granted the East India Company its Royal Charter on New Year's Eve in 1600, and during her reign the first colonies were founded in the Americas (Lawson 2014). In a detailed study of the effect of debt on Scottish elites, Douglas Watt suggests that by the late seventeenth century substantial debts drove highland chiefs to increase rents and to adopt increasingly commercial attitudes by engaging in new ventures. Watt gives the illuminating examples of the ninth Earl of Argyll who developed businesses in coal, maritime industries, and quarrying, and the Lord Neil Campbell and Sir Ewen Cameron who became involved in an attempt to establish colonies in the South Carolina and East New Jersey in the 1680s (Watt 2006: 48-49). Under Charles I further Caribbean and north American colonies were established, soon supplying England with food and fuel obtained through the labour of English colonists and, increasingly, African slaves, the trade of which soon motivated

the establishment of the first African colonies. All these overseas territories would expand and new colonies be founded in south America, Australasia, all across the Indian subcontinent, large areas of southern and eastern Africa, on the Arabian peninsular, and in parts of south east Asia (Canny 1998). At its largest, in 1925 the British Empire would eventually cover almost a quarter of the Earth's total land area (Taagepera 1997: 486).

Alongside this increase in territory, the amount of energy deriving from the burning of coal also steadily increased. In the mid-fifteenth century, the church and Crown combined had held around 25-35 percent of the land, aristocrats around 15 -20 percent, the non-titled gentry 25 percent, and yeomen and husbandmen the remainder, around 20 percent. But in 1536, after the Reformation, Henry VIII began the dissolution of the monasteries, beginning a period in which the Crown under Henry VIII and Elizabeth I weakened the power of the church and appropriated church land. Due partly to costly wars against France and Scotland, the Crown's financial difficulties led them to sell much of this land, so that by the late seventeenth century, although the aristocrats held roughly the same percentage of land as before and the yeoman and husbandmen held around a quarter or a third, the share of land controlled by the gentry had increased to around 50 percent, while the amount held by the church and Crown reduced to as little as five or ten percent (Hatcher 1993: 239).

Many former church lands had coal mines. In Roman Britain coal had been

burned domestically and for smelting but its used had declined rapidly with the rest of the British economy after the Roman withdrawal (A. H. V. Smith 1997, Malanima 2011: 8-9); and though the medieval Church had used coal as a cheap fuel for religious households, and landowners did sometimes lease the right to mine to their tenants, these leases were typically very restrictive, imposing severe limits on output and oppressive rents, and were generally only of quite short duration (Hatcher 1993: 241, 271). Whilst there was some variation in the leases granted, broadly speaking from the early fourteenth to the mid sixteenth century rights to mine had been leased at a fixed rate, and contained restrictions on output or labour. For example, one lease from 1306 prohibited the sale of the coal, another from 1326 limited the number of labourers to four, and another in 1486 limited the number of pickmen to three (Hatcher 1993: 274).

By the mid-sixteenth century, however, demand for coal was rising, coinciding with the localised depletion of woodland close to urban centres (Fouquet and Pearson 1998: 11-13, R. C. Allen 2003). With more and more coalfields taken from the Church, the terms of the tenancies were relaxed; and as demand for coal increased, so did the rent extracted by owners. As Hatcher writes, "These monumental changes in land ownership in the reigns of Henry and Elizabeth ... propelled the industry forwards" (Hatcher 1993: 272). Different leases began to be used whereby rent for a mine was paid either at a flat rate, or as a royalty, or as a share of the amount extracted, or in some combination of

the three. Particularly where royalties were to be paid, mining was no longer so restricted: indeed, minimum levels of extraction were now often required (Hatcher 1993: 273). In 1577, Elizabeth had extracted a 79-year lease of the manors of Whickham and Gateshead from the new bishop of Durham, Richard Barnes, which was extended into a 99-year lease in 1582 (Hatcher 1993: 514). Elizabeth apparently secured the lease for Robert Dudley, the earl of Leicester, who passed it to his servant, Thomas Sutton. The rent was set at £110, well below its market value, particularly as demand for coal was rapidly increasing. Sutton operated the mines for six years, making a large profit (Hatcher 1993: 515).

Coal stocks were far from scarce and many lay close enough to the surface to allow easy extraction. By 1583 coal was cheaper than firewood (R. C. Allen 2012: 20), and by 1600 coal cost about half as much as wood, in terms of the energy it produced (Smil 2010: 29; Fouquet 2008). However, until the development of the railways more than two centuries later, large quantities of coal could only be transported by water; moreover, the richest coalfields in England, and indeed the world, were in the Tyne valley in the north east where transport infrastructure inland was particularly poor (Hatcher 1993: 251). The scarcity in water transportation allowed the trade in English coal to become dominated by those that had controlled the waterways of the Tyne since the thirteenth century: the armigorous families of Newcastle who later became better known as the Newcastle Hostmen's Company (Hatcher

1993: 251). The case of the Hostmen highlights the way in which emerging entrepreneurs made use of existing customary previleges, converted into legal rights and maintained through persistent lobbying of successive parliaments, which secured them the rights to significant rents. The company was described in their 1600 charter of incorporation as a "gild or fraternity commonly called Hostmen, for the loading and better disposing of sea coals and pit coals, and stones called grind-stones, rub-stones and whet-stones, in, upon, and within our river or port of Tyne" and as having existed in Newcastle "from the time wherof the memory of man is not to the contrary" (Hatcher 1993:513). Though the charter is extremely vague on what these rights might be, and contains no mention of the right to a monopoly on sales of coal on the Tyne, it is clear that the Hostmen intended to continue claiming that right; in the same year, the Privy Council pronounced that "the buying, selling and lading of coal" was the rights of the Hostmen "by both custom and prescription time out of mind" (quoted in Hatcher 1993: 513). As well as a monopoly on trade, the Hostmen increasingly dominated production of Tyneside coal. Though the Hostmen had no special entitlement to the right to lease the collieries, they were in a very advantageous position from which to do so, since their monopoly on the transport and sale of coal could be used to prevent those other mines operating profitably (Hatcher 1993: 521-2). In one example, in 1616, after a prolonged dispute over rent with a leading Hostman, the ninth earl of Northumberland took back control of production from his collieries. The earl had previously supported the

Hostmen's in Parliament by opposing the bills to limit their powers. Now, as their competitor, the earl found that the Hostmen would deliberately lower the price of coal with the intention of forcing him out of business, that it was hard for him to hire the required workers despite in one case offering double pay, that the 'fitter' who acted as middleman charged him much higher rates, and that even buyers were reluctant to trade with him for fear of offending the Hostmen. Finally, two founder members of the Hostmen agreed to purchase the coal for a sum that would little more than cover the operating costs. As a result, the earl of Northumberland, despite his own wealth and despite owning a number of rich collieries, was unable to make money at all from coal production; after one of his collieries flooded the earl abandonned coal production altogether (Hatcher 1993: 519-21). At the time, complaints against the Hostmen noted that both the monopoly on the right to transport and trade and the monopoly on the right to the flow of production from the most productive collieries were now held by just "a few persons, being men of great wealth" (in Hatcher 1993: 515). As a result, those few people, around 18 or 20 in number, were able to "sell their seacoal at their own prices for the best advantage and the public detriment [and] by evil practice seek to increase their gain to the hurt of others, especially the poorer sort" (in Hatcher 1993: 515). Parliamentary bills in 1604 and 1606 opposing their charter of incorporation were soon dismissed (Hatcher 1993: 516). When in 1623 an act of Parliament was passed prohibitting monopolies, it contained a special provision entirely exempting the Hostmen's Company, and explicitly stating

that the act did not extend to, nor was it prejudicial to, any right whatsoever which the Hostmen enjoyed in the coal trade (in Hatcher 1993: 518). Despite repeated complaints against their monopoly, the Hostmen continued to enjoy the support of the monarchy with whom a mutually beneficial arrangement had been reached: the monarchy earned 12d. in revenues on the each chaldrons of coal shipped from the Tyne (Hatcher 1993: 515). Indeed, the Company of Hostmen and their successors would continue to operate a practical monopoly on Tyne coal until the railway system opened up new mines and alternative transport in the mid-nineteenth century (Fine 2013: 8).

Despite the Hostmen's monopoly, in terms of energy consumption coal use would overtake that of firewood by 1619 (Warde 2007: 116), and there were very few periods in the sixteenth and seventeenth century where demand for coal outstripped supply. Between 1550 and 1700, English coal output increased twelve-fold (Hatcher 1993: 256). New systems of transportation, coal, steam power, and the smelting of iron and steel together formed the key mutually reinfocing elements of the emerging industrial society, and allowed the processing and transport of materials at hithertofore unprecendented rates (Fischer-Kowalski and Schaffartzik 2015: 7). Almost uniquely in the world, British coal was located close to population centres; nowhere else on Earth had the same combination of a large population and cheap energy – with the possible exception of southern Belgium, though Belgian coal output

in 1800 would still amount to just 3 percent of that of Britain's (R. C. Allen 2009: 8). The high availability of coal, and its cheapness in comparison with labour, was an important driver for technological innovations. Robert Allen puts the argument made by Pomeranz, Bayly, and others in its stongest form: "technology was invented by people in order to make money", and since there were more coal mines in England than anywhere else, "it was only in Britain that the economic benefits were great enough to justify the expense of perfecting the steam engine. No one would have found it worthwhile anywhere else in the world" (Allen 2006: 2, 13). The improvements that Thomas Newcomen made to the steam engine in 1712 allowed water to be pumped out of coal mines to reach deeper seams, and when in 1800 James Watt and Matthew Boulton sold about 500 steam engines of their improved design they were sufficiently fuel efficient that they could actually be located away from a coal mine (Smil 2010: 52-53). By the mid-nineteenth century, steam engines had become sufficiently efficient that they would also be adopted in places like France where coal had previously been prohibitively expensive, and coal started to be used to fuel the steam ships beginning to replace the clippers that plied the very long trade routes of the British Empire (Allen 2006: 12). Biomass such as food, fodder, wood, and timber were imported from overseas colonies, with these material inputs from colonial expansion functionally vital to the socio-metabolic changes of Britain and then Europe's early industrialisation (Fischer-Kowalski and Schaffartzik 2015: 5, Pomeranz 2009, Bayly 2003: 60, 418, 468-469). In Britain, the use of wood for fuel became

negligible by the mid-nineteenth century, coinciding with the first use of oil for fuel; the consumption of oil in turn increased to overtake coal by the late twentieth century, by which time natural gas was also increasingly used, its use overtaking that of both coal and oil for the first time by the beginning of the twenty-first (Warde 2007: 120-122). Oil is cheaper to extract than coal and oil has a higher energy density, making it easier to transport and use in the combustion engines of both air and surface transport; though coal combustion remains important both for smelting and electricity generation, and both oil and gas forms the basis of an agrochemical industry responsible for manifold increases in agricultural productivity (Fischer-Kowalski and Schaffartzik 2015: 8).

As industrial technologies have diffused across the world, so has increasing use of coal, oil, and natural gas (Ayres 1990a; Ayres 1990b; Grübler 2003; Krausmann et al. 2008). Unprecedentedly large urban populations are now sustained by large quantities of food, fuel, and other resources brought into cities using transport themselves now largely run on fossil fuels (Gingrich et al. 2012, Fischer-Kowalski, Krausmann, et al. 2013). Globally, per capita energy consumption continues to grow (International Energy Agency 2017), but this growth is now beginning to slow (Ahmed 2017). Should our societies resource base cease to expand, then the history presented here may offer some indication of the social polarisation and tensions associated with creditors continuing to exact interest payments from debtors to whom they

have contracted loans of property, debtors who have no means to pay and no place to go. Though future predictions are inevitably speculative, this history may provide some cause for reflection as our own society approaches its limits to growth.

Conclusion

I have traced the evolution of titled property from its ancient origins to the modern period. Originating in the unique commercial practices of ancient Mesopotamia, the extension of these practices to agriculture caused problems that were resolved by Mesopotamian rulers periodically annulling titles that creditors had obtained. Lacking the central authority to enact similiar 'clean slates', the adoption of titled property in ancient Greece and Rome was initially accompanied by social conflict resolved through more sporadic debt forgiveness, and an energy subsidy provided by colonial expansion. The decline of the Roman Empire coincided with the decline of titled property institutions and the widespread appearance of serfdom in Europe, which persisted for a thousand years. Incremental reforms in England even before the Reformation saw the beginnings of the familiar social unrest. Temporarily interrupted by the Black Death, the process soon began again, further facilitated post-Reformation by the decriminalisation of titles to interest and the enactment of legislation facilitating the dispossession of land from de-

faulters. This most recent reestablishment of titled property institutions has spread globally, sustained through a long initial period of territorial expansion, and later by a massive ongoing energy subsidy provided largely by fossil fuels.

This narrative suggests that titled property has historically been able to survive only during periods in which energy resources are expanding; the mechanism behind this relationship is the fact that individual interest payments aggregated across a non-shrinking population can only be sustained by economic growth which is itself closely linked to increases in energy throughput. If this analysis is roughly correct, then an important and until now almost entirely neglected part of the coming transition away from fossil fuels will be a reexamination of the same difficult questions that previous epochs have faced, about how to distinguish property titles that have beneficial effects from those that ultimately harm us.

Chapter 8

Discussion, controversies, and future work

In my introductory chapter, I stated the purpose of the thesis to be to answer the question: *what are the characteristics of the energy resources of a society in which titled property institutions survive?* A short, unqualified answer to this question is simply: *they are expanding.* In this chapter, I will discuss the more important contributions of the thesis that have led to this conclusion, identifying areas where my work may be controversial, and suggesting what further work might help to resolve these controversies. The chapter has three sections, the first short section discussing the matters arising from the 'Concepts of ownership' chapter, the second a section discussing those arising from the 'Evolutionary model' chapter, and the third section discussing those

arising from the previous chapter, 'The evolution of titled property'; a short paragraph then summarises and concludes.

8.1 Discussion of the 'Concepts of ownership' chapter

The main contribution in the 'Concepts' chapter is a more nuanced taxonomy of ownership institutions that, in particular, can make better sense than existing taxonomies of the distinction between the ownership of resource stocks and resource flows. Relatedly, that chapter also shows that there are several similarities between the diverse conceptual schemes across different disciplines, most notably the tendency to have disputes that are essentially due to the neglect of the fundamental difference between resource stocks and resource flows. Though still poorly understood and rarely actually implemented, the arguments of those such as Kevin Gray, Ronald Coase, and the more recent work of scholars at the Ostrom Workshop in favour of viewing ownership as the entitlement of an individuals to take an action is a step supported by the analysis presented in this thesis.

In terms of controversy, the argument may be made that ownership need not be as complicated as I make it, and that it really should be thought of as a simple relationship between a person and an object, or in terms of

one of the existing schemes; but if the reader remains unconvinced by the arguments of the chapter itself, and by the example provided by this thesis of the utility of a more nuanced conceptualisation of ownership, then it is difficult to imagine what further argument or example can be provided here. Alternatively, the argument may be made that some other conceptual scheme of equal or greater nuance might reveal even more about the nature of ownership. Indeed, though no scheme can be as nuanced as reality itself, there may be reason to develop even more nuanced distinctions, or an alternative scheme altogether, as part of future work. After all, the process of conceptual clarification is itself an empirical process in which the meanings of words become established extentionally through their use by expert users. This is perhaps especially so in the case of the study of ownership regimes, where clarity over the meaning of ownership concepts has – from the earliest division between public and private to the most recent and detailed study of common pool resources – been obtained through observation about how institutions come to govern different types of resource in the real world. In that sense, the conceptual work I have conducted here is part of an ongoing process in which further divisions may become useful as further distinctions between different ownership institutions are observed.

8.2 Discussion of the 'Evolutionary game theory model' chapter

My next step in answering the question *what are the characteristics of the energy resources of a society in which titled property institutions survive?* has been to develop an evolutionary model for the mechanism by which individual behavioural norms might become coordinated in different insitutional arrangements depending on the characteristics of the energy resources used by those individuals. I noted in my first literature review that, though hypothesised, no mechanism had yet been proposed to explain the way by which the selection of ownership institutions takes place. So, the 'Evolutionary model' chapter contributes a simple and intuitive evolutionary mechanism for the way in which the different characteristics of energy resources might select for different ownership institutions.

As stated in that chapter, the key distinction of the model is that it develops existing models of the possessive behaviour hypothesised to occur in animals (J. M. Smith and Parker 1976; J. M. Smith and Szathmáry 1997; Kokko, López-Sepulcre, et al. 2006; Alcock 2005; Krier 2009; Stake 2004; Gintis 2009) into a model that also applies to the human ownership institutions of communal, command, and titled property ownership. Previous models of the evolution of ownership have, unsurprisingly, faced the same problem I highlighted in my 'Concepts' chapter: failing to make a distinction between

the ownership of resource stocks and resource flows, they have got as far as modelling territorial possessiveness but are prevented from progressing further, since the assumption that the paradigm form of ownership is that of the resource stock such as land would have made modelling communal ownership, if not impossible, then at least highly unintuitive.

The model has provided a heuristic for constructing a narrative of the evolution of all four 'ideal type' ownership institutions. Though in this thesis I have focussed on titled property, the model does also suggest narratives for the evolution of the other three, extended discussion of which would be an important task in future work. Without going into too much more detail here, my preliminary research suggests three main controversies that these narratives would enter into. In increasing order of how likely I think they are to provoke disagreement, these are: the issue of the exogeneity of energy resource change; the identification of transitional points; and the 'stickiness' of institutions.

The first controversy is due to the fact that the model assumes changes in energy resource to be exogenous to institutional change. Though it is clear that there are interaction effects between resources and institutions, my preliminary research suggests that there is sufficient empirical evidence for the exogeniety of energy resource change for this to be a fairly defensible assumption simply based upon the order of events, since transitions to new resources and to new institutions do typically seem to occur after some de-

gree of depletion of the previous resource base. My preliminary survey, set out in the second literature review, suggests that the transition to hunting in the savanna was the end result of a long evolutionary process preceded by the decline of the forests (Vrba 1993, Bobe 2004, Edwards and S. A. Smith 2010, Macho 2014), and that the transition to domesticates fairly certainly in western Asia but also very probably elsewhere was preceded by the precipitous decline of large game (Stiner, N. D. Munro, et al. 2000, N. Munro et al. 2004, Brook and Barnosky 2012, Speth 2013). As for the depletion of biomass resources prior to expansionary colonialism and to the increased use of fossil fuels, in the case of England it is clear that the decline in British forests in the mid-sixteenth century prompted an increase in the import of wood and timber as well as contributing to the attractiveness of burning of coal despite its poisonous sulphurous smoke (Fouquet and Pearson 1998, Krausmann et al. 2008, R. C. Allen 2012). More detailed interdisciplinary work is severely lacking into the differences and similarities between these energy transitions and the coevolution of the various factors, with further work in this direction likely proving a useful contribution towards unpicking the way in which different factors interact and become mutually reinforcing.

A second controversy is the more general problem of providing a point in the narrative where one kind of ownership institution becomes another. This is the inevitable result of taking an evolutionary approach, and is in fact a sign that the evolutionary narrative being told is plausible: the gradual

evolution of titled property out of command ownership institutions that I outlined in the previous chapter serves as an illustration of this. Since there are so many nuanced changes that just slightly alter an existing institution, nudging behaviour slightly away from one type of ownership and slightly towards another, it is a good sign that it is difficult to state exactly where the transition from one to another takes place. For example, according to my preliminary research, hominins were hunting smaller animals at least two million years ago (Ferraro et al. 2013, Ferraro et al. 2013) and controlling fire at least 790,000 years ago (Goren-Inbar et al. 2004), but not until 200,000 years ago is there the first evidence of communal butchering and sharing of meat, a change that coincided with the earliest evidence for the hunting of much larger animals (Stiner, Barkai, et al. 2009, Gintis et al. 2015). However, communal eating probably did not appear spontaneously, and it would be useful research to set out the different kinds of evidence for the incremental narrative of what changes may have occured in the evolution of communal ownership and of social carnivory. Similarly, ever more archaeological evidence suggests that the transition to agriculture in Western Asia and elsewhere was a slow and often interrupted process (Price and Bar-Yosef 2011); a similar evolutionary narrative reviewing the evidence of the institutional changes during this time would provide a useful insight into the way in which command ownership institutions may actually have evolved.

Relatedly, the third controversy relates to the stickiness of institutions. A

particular example relates to my interpretation of the evolutionary model to suggest that communal ownership survives amongst hunter-gatherers because their main energy resource, wild game, is unpredictable. Though the 'variance reduction hypothesis' is widely held among anthropologists, others have argued that ethnographic studies have shown several hunter-gatherer groups not to suffer a great deal of variance, but nevertheless to hunt and to share food (Sanderson 2007: 217-219 is a useful short review). It may be that my work here helps clarify this debate, for it suggests that though the availability of game may no longer by so unpredictable, the institution of communal ownership once it has evolved can neverthless persist when sustained, for example by the values of generosity and of prestige towards successful hunters. In the absence of some shock that makes the survival of those institutions and behaviours less likely, these institutions may continue with few changes even once the original circumstances in which they evolved no longer persist. Similarly, deference towards hereditary royalty may survive long after conditions change, and as I suggested in my narrative chapter on titled property, people have often attempted to maintain titled property institutions even though their society collapses around them as a result. My responses here are of course based only upon my preliminary research, and further work on the question is required.

8.3 Discussion of the 'Evolution of titled property' chapter

The key contribution of the 'Evolution of titled property' chapter is a continuous narrative of the evolution of titled property from its origins to the modern period. Sidney Homer's classic *A History of Interest Rates* and David Graeber's more recent *Debt: the First 5,000 Years* were useful initial sources, though their emphasis is on the long history of interest rates and the effects of debt, respectively, and neither enquire into the conditions in which titled property institutions survive, nor reflect at all upon the relationship between titled property and energy resources. The 'Evolution of titled property' chapter, then, has contributed an analysis that allows important parrallels between different historical periods to be highlighted and some oft hidden continuities to be brought to the fore. In the future a more detailed version would also be useful and instructive, as would the statistical testing of some of these claims wherever data is available.

The chapter engages in two key controveries, both related to the dating of the appearance of titled property. The first controversy surrounds the claim that titled property institutions existed even in premodern societies. The second controversy is that I place the key institutional developments in England several centuries before some other scholars.

Regarding the first of these controversies, it is worth emphasising that my

argument is not that behaviour resembling a narrowly self-interested *homo economicus* is humanity's natural state; the fact that I explicitly set out several other ownership institutions that have been at least as prevalent throughout human history should make this plain. Further, my research actually suggests that the institution of titled property, an institution which arguably encourages self-interested behaviour, is something of a historical anomaly that has survived fairly temporarily and only in fairly unusual energetic conditions. As I discussed throughout the chapter, even where titled property does survive it is frequently criticised as unnatural by individuals within those societies, just as it has been in the current epoch. Though my research into the specificity of the origins of interest in ancient societies closely follows the work of those with greater expertise in these fields, and to the best of my ability reflects the current state of knowledge of those specialists, my qualified conclusion on page 183 of this thesis that "Mesopotamians are quite likely to be the first and only civilisation in history to have invented loans at interest" would benefit from further work to establish that claim with more certainty. Similarly, further research into the diffusion of titled property institutions, and particularly the effects of and response to the socially deleterous effects of its adoption, would allow a greater comparison between economies both ancient and modern, and provide a clearer picture of the fate of titled property institutions beyond the western Asian, Mediterranean, and European context.

Secondly, like many of the scholars I cite, I begin my account of the evolution of titled property in England with the legal changes of the twelfth century. I have made the case in the chapter that an evolutionary account that aims to explain these processes in terms of incremental changes through a continuous narrative has some merit, and may even serve as something of a corrective to the fairly prevalent view that institutional change is typically the result of shocks or 'big bangs' (see also Kopsidis and Bromley 2016). Again, the purpose of my account is not to dispute that later changes do not also have important effects. Clearly, the European wars and territorial uprisings, the civil war, the conquests, the Restoration, the Dutch invasion known as the 'Glorious Revolution', the Bill of Rights, and the establishment of the Bank of England in the seventeenth century, and the legislation allowing negotiability of promissory notes, the financial and administrative reforms, the increasing consolidation of open fields, and the development of factories employing the urban proletariat in the eighteenth are all important developments. But rather than argue for the greater importance of one of these events over another, it seems to me that it might be more sensible to see them as part of a longer, more incremental, evolutionary process. As suggested in the section above, further work following such an approach may help clarify the way in which these different processes interact and how different patterns, institutions, and behaviours have actually come to evolve.

Conclusion

In this discussion chapter, I have summarised the main contributions of the thesis, placed them in the context of the ongoing controversies to which they contribute, and suggested ways in which further work might continue to shed light on these controversies. Taken together, the thesis contributes a coherent taxonomy of ownership institutions governing different resource types forming part of an ongoing process of conceptual clarification within and between disciplines; contributes an evolutionary model of human ownership institutions and suggests ways in which future research may help further illuminate the persistence of institutions and the reasons they change; and contributes an evolutionary account of the evolution of titled property that may function as an alternative to the 'big bang' accounts and suggests that further work on more incremental institutional change may be similarly illuminating.

Chapter 9

Conclusion

Previous grand energy transitions – to hunting large animals, to domesticates, and to fossil fuels – have been accompanied by civilisational transformations in economic and political institutions. A question of particular interest to political economists is why these transitions have been accompanied by changes in the ownership institutions governing resources, a question central to the study of political economy since the early beginnings of the discipline.

As Julien-Francois Gerber and Rolf Steppacher write: in the last few centuries, a "unique potential was historically created by combining mineral resources with the institution of property" (J.-F. Gerber and Steppacher 2014: 458). This unique potential, on the analysis of this thesis, is that the explosive expansionary drive for growth associated with titled property, present since its inception over five millenia ago, became for the first time

fuelled by extensive use of a non-biomass resource. There is reason to believe, however, that this unique historical period is now coming to an end. Though not yet shrinking, since the late twentieth century global energy growth has begun to slow down (Ahmed 2017: 15). Over the same period, the energy return from extracting fossil fuels has undergone a steady decline as higher quality resources have become depleted, leading to the exploitation of ever lower quality fuels that require ever more energy to obtain and refine (Ahmed 2017: 15). Nuclear fuels are not the panacea they once appeared: the mining, enrichment, conversion, and disposal processes involved in nuclear fuel technologies are themselves heavily dependent on fossil fuels and relatively scarce minerals for reactor construction, and the nuclear fuel itself is similarly susceptible to declining energy returns as a result of the declining quality of ore available; within the next few decades, high grade ore is predicted to become rapidly depleted (Trainer 2014: 171, Fischer-Kowalski and Schaffartzik 2015: 10, Ahmed 2017: 21).

Unlike mineral resources, renewable energy resources will not become depleted. Of these, there are nine major kinds – solar, hydro, wind, waves, ocean currents, ocean thermal, photosynthesis, gothermal, and tidal – of which direct solar radiation is the only one with any possibility of surpassing the amount of energy currently provided by fossil fuels (Smil 2010: 109-116). The question remains of how much solar energy might actually be captured, though both the materials required for the construction of photovoltaics and

the areas that they may be placed without directly competing with food production are limited (Trainer 2012, Smil 2010: 117). Noting that proposals to harness sunlight in space have "no chance of large-scale commercialization during the coming generation or two", Smil estimates that if renewables were to satisfy even 15 to 30 percent of current fuel and electricity demand then the amount of land required would be "unrealistically large" (Smil 2010: 117).

The analysis of this thesis suggests that whilst titled property institutions have historically survived as long as resource transfers can be motivated by the promise of higher returns, in the absence of resource expansion these institutions tend to result in increasing social polarisation and often the return of more directly coercive command ownership institutions. Any predictions about the future would be inevitably speculative. But barring currently unforeseen developments, the current period of energy expansion seems to be coming to an end. A better understanding of the ways that ownership institutions motivate and govern the transfer of resources may help us better understand the political economic consequences that result.

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